Tiltak for elektronisk deling av pasientinformasjon

Notat fra Kunnskapssenteret

Systematisk litteratursøk med sortering

August 2015

kunnskapssenteret

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Nasjonalt kunnskapssenter for helsetjenesten fremskaffer og formidler kunnskap om effekt av metoder, virkemidler og tiltak og om kvalitet innen alle deler av helsetjenesten. Målet er å bidra til gode beslutninger slik at brukerne får best mulig helsetjenester. Kunnskapssenteret er formelt et forvaltningsorgan under Helsedirektoratet, men har ingen myndighetsfunksjoner og kan ikke instrueres i faglige spørsmål.

Nasjonalt kunnskapssenter for helsetjenesten
Oslo, august 2015

Hovedfunn

Nasjonalt kunnskapssenter for helsetjenesten fikk i oppdrag av Helsedirektoratet å utføre et systematisk litteratursøk med påfølgende sortering av mulig relevante publikasjoner. Oppdraget var å finne litteratur/forskning om elektronisk deling av pasientinformasjon mellom fagfolk, enheter eller institusjoner.

Metode

Vi utarbeidet søkestrategi for et systematisk litteratursøk. Det ble søkt i medisinske databaser etter forskningsstudier og systematiske oversikter. Søket ble utført i april 2015. To medarbeidere gikk uavhengig av hverandre gjennom identifiserte publikasjoner/ referanser og vurderte relevans i forhold til inklusjonskriteriene.

Resultater

Vi identifiserte totalt 7075 referanser Av disse vurderte vi at 167 var mulig relevante. Vi sorterte referansene i 6 kategorier ut fra type tiltak og studiedesign.

- Kategori 1 besto av 55 systematiske oversikter som dekket ulike tiltak.
- Kategori 2-6 besto av randomiserte og ikke-randomiserte studier og observasjonsstudier og ble fordelt etter tiltak rettet mot henholdsvis:
    - samhandling mellom tjenestenivåer og fagfolk (54 referanser)
    - henvisninger og tester (6 referanser)
    - forskrivning og medikamenthåndtering (46 referanser)
    - uønskede hendelser (2 referanser)
    - folkehelsetiltak (3 referanser)

Tittel:

Tiltak for elektronisk deling av pasientinformasjon

Publikasjonstype:

Systematisk litteratursøk med sortering

Systematisk litteratursøk med sortering er resultatet av å
- søke etter relevant litteratur ifølge en søkestrategi og
- eventuelt sortere denne litteraturen i grupper presentert med referanser og vanligvis sammendrag

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Svarer ikke på alt:

- Ingen kritisk vurdering av studienes kvalitet
- Ingen analyse eller sammenfatning av studiene
- Ingen anbefalinger

Hvem står bak denne publikasjonen?

Kunnskapssenteret har gjennomført oppdraget etter forespørsel fra Helsedirektoratet

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Når ble litteratursøket utført?

April 2015

Key messages

The Norwegian Knowledge Centre for the Health Services was commissioned by the Norwegian Directorate of Health to perform a systematic search of studies evaluating the effect of interventions for sharing of electronic patient records.

Methods

We designed and carried out a systematic search in relevant databases, including Medline, Embase, CENTRAL and DARE. The search was finalised in April 2015. Two or more researchers independly reviewed all references for potential inclusion based on explicit criteria.

Results

We identified a total of 7075 referances. Of these, 167 were judged as potential relevant. We sorted the potential relevant references in 6 categories based on intervention and study design.

- Category 1 included 55 systematic reviews of different interventions.
- Category 2-6 included randomised or non-randomised trials and observational studies, and the following interventions:
  - interactions between levels of health care or personnel (54 references),
  - referrals and tests (6 references),
  - prescribing and medication management (46 references),
  - adverse events (2 references)
  - public health interventions (3 references)

Title:
Interventions for sharing of electronic patient records

Type of publication:

Systematic reference list

A systematic reference list is the result of a search for relevant literature according to a specific search strategy. The references resulting from the search are then grouped and presented with their abstracts.

Doesn't answer everything:

- No critical evaluation of study quality
- No analysis or synthesis of the studies
- No recommendations

Publisher:

Norwegian Knowledge Centre for the Health Services

Updated:

April, 2015.

Innhold

Forord

Nasjonalt kunnskapssenter for helsetjenesten fikk i oppdrag av Helsedirektoratet ved Ida Møller Solheim å finne litteratur om effekt av elektronisk informasjonsdeling på tvers av virksomheter i helsetjenesten. Notatet utgjør et dokumentasjonsgrunnlag for videre diskusjon om slike tiltak samt ved planlegging av nye systematiske oversikter der slike ikke finnes.

Prosjektgruppen har bestått av:

- Astrid Austvoll-Dahlgren, prosjektleder og seniorforsker, Nasjonalt kunnskapssenter for helsetjenesten
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Gro Jamtvedt	Gunn E Vist	Astrid Austvoll-Dahlgren
Avdelingsdirektør	*Seksjonsleder*	*Prosjektleder*

Problemstilling

Formålet med dette notatet er å lage en liste over systematiske oversikter og primærstudier som har sett på effekt av tiltak for elektronisk deling av pasientinformasjon mellom fagfolk, enheter eller institusjoner.

Innledning

Nasjonalt kunnskapssenter for helsetjenesten fikk i oppdrag av Helsedirektoratet å utføre et systematisk litteratursøk med påfølgende sortering av mulig relevante publikasjoner. Oppdraget var å finne litteratur/forskning om elektronisk deling av pasientinformasjon mellom fagfolk, enheter eller institusjoner. Systemer for å dele pasientinformasjon på denne måten er antatt å standardisere og forbedre informasjonsflyt, som igjen er antatt å gi bedre og mer relevante tjenester, mer fornuftig bruk av helsetjenester og å fremme pasientsikkerhet.

Formålet med dette notatet er å gi en oversikt over litteraturen som finnes på området, og erstatter ikke en systematisk oversikt over effekt av slike tiltak. Notatet utgjør imidlertid et relevant dokumentasjonsgrunnlag for videre diskusjon om slike tiltak og er et utgangspunkt for planlegging av nye systematiske oversikter der slike ikke finnes.

Ved utarbeidelse av litteratursøk med sortering gjennomfører vi systematiske litteratursøk for en gitt problemstilling. Resultatene fra søket blir i sin helhet overlevert oppdragsgiver, eller vi kan gjennomgå søkeresultatet før overleveringen og sortere ut ikke-relevante artikler. Dette gjøres basert på tittel og eventuelt sammendrag. Artiklene innhentes ikke i fulltekst. Det gjør at vi kan ha inkludert titler som ville vist seg å ikke å være relevante ved gjennomlesning av fulltekst. Vi benytter kun databaser for identifisering av litteratur, og kan derfor ha gått glipp av potensielt relevante studier. Andre måter å identifisere studier på, som søk i referanselister, kontakt med eksperter på fagfeltet og upublisert litteratur, er ikke utført i dette oppdraget. Vi har heller ikke gjennomført kvalitetsvurdering av artiklene. Formålet med søket har vært å finne studier som ser på effekt av tiltak. Vi har derfor søkt etter både oppsummert forskning samt primærstudier som har hatt til hensikt å måle effekter av slike tiltak.

Ved en full forskningsoppsummering ville vi ha innhentet artiklene i fulltekst for endelig vurdering opp mot inklusjonskritene. Inkluderte studier ville så blitt kvalitetsvurdert i henhold til våre sjekklister og resultater sammenstilt og diskutert.

Metode

Litteratursøking

Vi søkte systematisk etter litteratur i følgende databaser:

- Embase
- Medline
- Cochrane Central Register of Controlled Trials (CENTRAL)
- DARE, HTA via Cochrane Library Medline
- DARE, HTA via Centre for Reviews and Dissemination Cochrane Library

Bibliotekar Gyri Hval Straumann planla og utførte samtlige søk. Søkestrategien er fagfellevurdert av en annen bibliotekar, Marit Johansen. Den fullstendige søkestrategien er vist i vedlegg 1. Søk etter studier ble avsluttet april 2015.

Vi la inklusjonskriteriene til grunn ved utarbeiding av litteratursøket og søkte etter artikler som oppfylte våre inklusjonskriterier for tiltak, studiedesign og publikasjonsår (se vedlegg 1 for fullstendig søkestrategi).

Vi la bestillingen til grunn ved utarbeiding av litteratursøket og søkte etter artikler som oppfylte våre inklusjonskriterier for populasjon og tiltak.

Inklusjonskriterier

Populasjon:	Fagfolk, enheter eller institusjoner innen helse
Tiltak:	Tilgang til eller mulighet for utveksling av pasientinformasjon uansett organisasjonstilhørighet. Inklusive meldesystemer.
Sammenlikning:	Andre måter å dele informasjon på, eller uten system for deling
Utfall:	Alle
Studiedesign	Systematiske oversikter, randomiserte kontrollerte studier, studier med kontrollgruppe eller avbrutte tidsserieanalyser
Språk:	Ingen begrensninger i søket

Artikkelutvelging

To medarbeidere (AA, GHS eller AGU) gikk gjennom alle titler og sammendrag for å vurdere relevans i henhold til inklusjonskriteriene. Vurderingene gjorde vi uavhengig av hverandre og sammenlignet i etterkant. Der det var uenighet om vurderingene, ble inklusjon eller eksklusjon avgjort ved konsensus. Utvelging av litteratur ble kun gjort basert på tittel og sammendrag. Vi bestilte ikke fulltekst av artiklene.

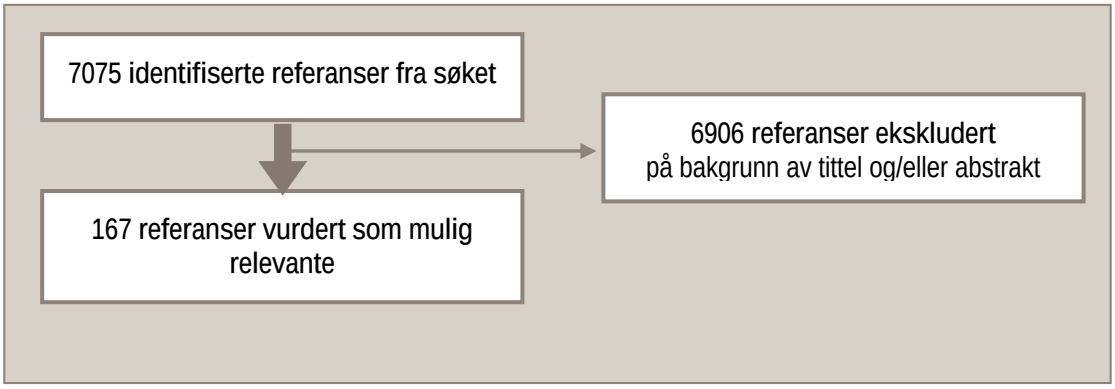
Vi gjør oppmerksom på at formålet med elektronisk deling av pasientinformasjon i mange tilfeller er å dele slik informasjon med pasientene selv. Slike studier er imidlertid ikke inkludert i dette notatet da bestillingen fra Helsedirektoratet var å se på effekt av elektronisk deling av pasientinformasjon mellom fagfolk, enheter eller institusjoner.

Resultat

Resultat av søk

Søket resulterte i 7075 unike referanser. Vi vurderte 167 av disse referansene til å være mulig relevante i henhold til inklusjonskriteriene.

Hovedårsaken til eksklusjon var at publikasjonen ikke omhandlet deling av informasjon, eksempelvis tiltak som beslutningsstøttesystemer, eller at de ikke møtte inklusjonskriteriene for studiedesign (kvalitative studier eller studier som ikke benyttet seg av kontrollgruppe).



Figur 1. Flytskjema over identifisert litteratur

Resultat av sorteringen

De mulig relevante referansene ble sortert i 6 kategorier ut fra type tiltak og studiedesign (se tabell 1). Vi valgte å presentere de systematiske oversiktene i en kategori for seg fordi mange av disse omfattet tiltak på tvers av de ulike tiltakskategoriene (se tabell 2). I vedlegg 2 presenterer vi referansene for de resterende referansene etter type tiltak, design og alfabetisk etter førsteforfatter. Vi oppgir forfattere, tittel på publikasjonen, publikasjonssted og sammendrag av artikkelen slik de fremkom i de elektroniske databasene.

Tabell 1: *Oversikt over referanser for elektronisk deling av pasientinformasjon*

Tiltak	Antall referanser	Side i notat
Systematiske oversikter (1-55)	55	11
Samhandling mellom tjenestenivåer og fagfolk (56-109)	54	43
Henvisninger og tester (110-115)	6	68
Forskrivning og medikamenthåndtering (116-162)	46	71
Uønskede hendelser (meldeordninger) (163, 164)	2	91
Folkehelse (meldeordninger) (165-167)	3	93

Tabell 2: *Systematiske oversikter presentert alfabetisk etter førsteforfatter*

Electronic tools for health information exchange: an evidence-based analysis (Structured abstract). Health Technology Assessment Database Health Quality Ontario; 2013.
Adane K, Muluye D, Abebe M. **Processing medical data: a systematic review**. Archives of Public Health 2013;71(1):27. Abstract: BACKGROUND: Medical data recording is one of the basic clinical tools. Electronic Health Record (EHR) is important for data processing, communication, efficiency and effectiveness of patients' information access, confidentiality, ethical and/or legal issues. Clinical record promote and support communication among service providers and hence upscale quality of healthcare. Qualities of records are reflections of the quality of care patients offered. METHODS: Qualitative analysis was undertaken for this systematic review. We reviewed 40materials Published from 1999 to 2013. We searched these materials from databases including ovidMEDLINE and ovidEMBASE. Two reviewers independently screened materials on medical data recording, documentation and information processing and communication. Finally, all selected references were summarized, reconciled and compiled as one compatible document. RESULT: Patients were dying and/or getting much suffering as the result of poor quality medical records. Electronic health record minimizes errors, saves unnecessary time, and money wasted on processing medical data. CONCLUSION: Many countries have been complaining for incompleteness, inappropriateness and illegibility of records. Therefore creating awareness on the magnitude of the problem has paramount importance. Hence available correct patient information has lots of potential in reducing errors and support roles.
Ajami S, Lamoochi P. **Use of telemedicine in disaster and remote places**. Journal of Education & Health Promotion 2014;3:26. Abstract: One of the methods, especially those living in remote areas or have crashed and does not have access to specialists is telemedicine. Telemedicine describes the use of medical information exchanged from one site to another via electronic communications to improve patients' health status and care. Travel and wait times between the initial consultations with the patient's own general practitioner and referral to specialist can be reduced and specialists have successfully provided remote triage and treatment consults of victims

via the robot. The robot proved to be a useful means to extend resources and provide expert consulting if specialists were unable to physically be at the site. In fact, the telemedicine system is providing health care services for individuals who are not available because of geographical and environmental conditions. The aim of this study was to identify telemedicine applications in disaster, and proposed use of this technology in areas where the shortage of specialists in remote areas in disasters. This study was un-systematic (narrative) review. The literature was searched for using of telemedicine in disaster and remote places with the help of libraries, conference proceedings, data bank, and also search engines available at Google, Google scholar. In our searches, we employed the following keywords and their combinations: telemedicine, remote place, earthquake, disaster, war, and telecommunication in the searching areas of title, keyword, abstract, and full text. In this study, more than 85 articles and reports were collected and 26 of them were selected based on their relevancy. This literature review helps define the concept of "components and usages of the Telemedicine in disaster" as the new technology in the present age.

Akbari A, Mayhew A, Al-Alawi Manal A, Grimshaw J, Winkens R, Glidewell E, et al. **Interventions to improve outpatient referrals from primary care to secondary care**. Cochrane Database of Systematic Reviews John Wiley & Sons, Ltd; 2008.
Abstract: Background: The primary care specialist interface is a key organisational feature of many health care systems. Patients are referred to specialist care when investigation or therapeutic options are exhausted in primary care and more specialised care is needed. Referral has considerable implications for patients, the health care system and health care costs. There is considerable evidence that the referral processes can be improved.Objectives: To estimate the effectiveness and efficiency of interventions to change outpatient referral rates or improve outpatient referral appropriateness. Search methods: We conducted electronic searches of the Cochrane Effective Practice and Organisation of Care (EPOC) group specialised register (developed through extensive searches of MEDLINE, EMBASE, Healthstar and the Cochrane Library) (February 2002) and the National Research Register. Updated searches were conducted in MEDLINE and the EPOC specialised register up to October 2007.Selection criteria: Randomised controlled trials, controlled clinical trials, controlled before and after studies and interrupted time series of interventions to change or improve outpatient referrals. Participants were primary care physicians. The outcomes were objectively measured provider performance or health outcomes. Data collection and analysis: A minimum of two reviewers independently extracted data and assessed study quality.Main results: Seventeen studies involving 23 separate comparisons were included. Nine studies (14 comparisons) evaluated professional educational interventions. Ineffective strategies included: passive dissemination of local referral guidelines (two studies), feedback of referral rates (one study) and discussion with an independent medical adviser (one study). Generally effective strategies included dissemination of guidelines with structured referral sheets (four out of five studies) and involvement of consultants in educational activities (two out of three studies). Four studies evaluated organisational interventions (patient management by family physicians compared to general internists, attachment of a physiotherapist to general practices, a new slot system for referrals and requiring a second 'in-house' opinion prior to referral), all of which were effective. Four studies (five comparisons) evaluated financial interventions. One study evaluating change from a capitation based to mixed capitation and fee-for-service system and from a fee-for-service to a capitation based system (with an element of risk sharing for secondary care services) observed a reduction in referral rates. Modest reductions in referral rates of uncertain significance were observed following the introduction of the general practice fundholding scheme in the United Kingdom (UK). One study evaluating the effect of providing access to private specialists demonstrated an increase in the proportion of patients referred to specialist services but no overall effect on referral rates. Authors' conclusions:

There are a limited number of rigorous evaluations to base policy on. Active local educational interventions involving secondary care specialists and structured referral sheets are the only interventions shown to impact on referral rates based on current evidence. The effects of 'in-house' second opinion and other intermediate primary care based alternatives to outpatient referral appear promising.

Ali MK, Shah S, Tandon N. **Review of electronic decision-support tools for diabetes care: A viable option for low- and middle-income countries?** J Diabetes Sci Technol 2011;5(3):553-570. Abstract: Context: Diabetes care is complex, requiring motivated patients, providers, and systems that enable guideline-based preventative care processes, intensive risk-factor control, and positive lifestyle choices. However, care delivery in low- and middle-income countries (LMIC) is hindered by a compendium of systemic and personal factors. While electronic medical records (EMR) and computerized clinical decision-support systems (CDSS) have held great promise as interventions that will overcome system-level challenges to improving evidence-based health care delivery, evaluation of these quality improvement interventions for diabetes care in LMICs is lacking. Objective and Data Sources: We reviewed the published medical literature (systematic search of MEDLINE database supplemented by manual searches) to assess the quantifiable and qualitative impacts of combined EMR-CDSS tools on physician performance and patient outcomes and their applicability in LMICs. Study Selection and Data Extraction: Inclusion criteria prespecified the population (type 1 or 2 diabetes patients), intervention (clinical EMR-CDSS tools with enhanced functionalities), and outcomes (any process, self-care, or patient-level data) of interest. Case, review, or methods reports and studies focused on nondiabetes, nonclinical, or in-patient uses of EMR-CDSS were excluded. Quantitative and qualitative data were extracted from studies by separate single reviewers, respectively, and relevant data were synthesized. Results: Thirty-three studies met inclusion criteria, originating exclusively from high-income country settings. Among predominantly experimental study designs, process improvements were consistently observed along with small, variable improvements in risk-factor control, compared with baseline and/or control groups (where applicable). Intervention benefits varied by baseline patient characteristics, features of the EMR-CDSS interventions, motivation and access to technology among patients and providers, and whether EMR-CDSS tools were combined with other quality improvement strategies (e.g., workflow changes, case managers, algorithms, incentives). Patients shared experiences of feeling empowered and benefiting from increased provider attention and feedback but also frustration with technical difficulties of EMR-CDSS tools. Providers reported more efficient and standardized processes plus continuity of care but also role tensions and "mechanization" of care. Conclusions: This narrative review supports EMR-CDSS tools as innovative conduits for structuring and standardizing care processes but also highlights setting and selection limitations of the evidence reviewed. In the context of limited resources, individual economic hardships, and lack of structured systems or trained human capital, this review reinforces the need for well-designed investigations evaluating the role and feasibility of technological interventions (customized to each LMIC's locality) in clinical decision making for diabetes care. © Diabetes Technology Society.

Ammenwerth E, Schnell-Inderst P, Machan C, Siebert U. **The effect of electronic prescribing on medication errors and adverse drug events: a systematic review (Structured abstract)**. J Am Med Inform Assoc2008. p. 585-600.

Anastassopoulos KP, Mann R, Knight TG, Sudharshan L, Ackerman SJ. **Use of electronic medical records from 2001 through 2010: Implications for comparative effectiveness research**. Value Health 2011;14 (3):A25. Abstract: OBJECTIVES: Recent developments in the United States (US) health care reform and funding for comparative effectiveness re-

search suggest that use of electronic medical records (EMR) in outcomes research may increase over time. EMR can be particularly useful when outcomes are not well-defined with diagnosis or procedures codes or when clinical data are needed. The objective of this study was to review trends in the use of EMR during the past decade. METHODS: A review of published literature was conducted in PubMed for years 2001 through 2010 to identify outcomes studies in the US that used EMR. Internal quality assurance studies and validation studies that used EMR were excluded. The number of studies, set- tingofcare, patient population, whether the study was comparative, and any noted limitations were examined. RESULTS: A total of 58 EMR-based, outcomes studies in the US were identified over the past decade; increasing from 3 in 2001 to 12 in 2010. The majority of studies included outpatient EMR. Studies included a variety of patient populations with over one-third in cardiovascular disease, psychiatric disease, and diabetes combined. The percent of studies that were comparative ranged from 0% in 2001 to 45% in 2010. Measures of effectiveness varied widely and included lab values, clinical measures, and health-related quality-of-life outcomes. Some noted limitations on the use of EMR data in outcomes research included lack of representativeness ofall care delivered across practice settings, lack of generalizability and standardization, and reliance on health care provider reporting. CONCLUSIONS: Although the use of EMR in outcomes research has increased slowly in the past decade, the proportion of comparative studies using EMR has increased over time. As the industry works to standardize EMR and more advanced outcomes are collected in EMR systems, EMR data may play a larger role in comparative effectiveness research.

Archie RR, Boren SA. **Opportunities for informatics to improve discharge planning: a systematic review of the literature**. AMIA Annual Symposium Proceedings/AMIA Symposium 2009;2009:16-20.

Abstract: The discharge planning process can be successful when information is shared among the patient, caregiver, and provider from admission through post discharge. The objective of this paper was to evaluate the association of information sharing among patients, caregivers, and health care providers and the impact on the discharge process. The authors identified reports of the discharge planning process through systematic electronic database searches. The eligibility criteria were 1) usual discharge planning process, and 2) patient, caregiver, or provider perception or feedback. Of the eligible articles, all voiced concern about a broken discharge planning process that affected the information exchanged among all involved in patient care. Outcomes related to satisfaction, knowledge transfer, and communication were identified. The initial evidence suggests information sharing through interdisciplinary patient care can play a significant role in the future.

Aubin M, Giguère A, Martin M, Verreault R, Fitch Margaret I, Kazanjian A, et al. **Interventions to improve continuity of care in the follow-up of patients with cancer**. Cochrane Database of Systematic Reviews John Wiley & Sons, Ltd; 2012.

Abstract: Background: Care from the family physician is generally interrupted when patients with cancer come under the care of second-line and third-line healthcare professionals who may also manage the patient?s comorbid conditions. This situation may lead to fragmented and uncoordinated care, and results in an increased likelihood of not receiving recommended preventive services or recommended care.Objectives: To classify, describe and evaluate the effectiveness of interventions aiming to improve continuity of cancer care on patient, healthcare provider and process outcomes.Search methods: We searched the Cochrane Effective Practice and Organization of Care Group (EPOC) Specialised Register, the Cochrane Central Register of Controlled Trials (CENTRAL), PubMed, EMBASE, CINAHL, and PsycINFO, using a strategy incorporating an EPOC Methodological filter. Reference lists of the included study reports and relevant reviews were also scanned, and ISI Web of Science and Google Scholar were used to identify relevant reports having cited the studies included in this review. Selection criteria: Randomised controlled trials

(including cluster trials), controlled clinical trials, controlled before and after studies and interrupted time series evaluating interventions to improve continuity of cancer care were considered for inclusion. We included studies that involved a majority (> 50%) of adults with cancer or healthcare providers of adults with cancer. Primary outcomes considered for inclusion were the processes of healthcare services, objectively measured healthcare professional, informal carer and patient outcomes, and self-reported measures performed with scales deemed valid and reliable. Healthcare professional satisfaction was included as a secondary outcome. Data collection and analysis: Two reviewers described the interventions, extracted data and assessed risk of bias. The authors contacted several investigators to obtain missing information. Interventions were regrouped by type of continuity targeted, model of care or interventional strategy and were compared to usual care. Given the expected clinical and methodological diversity, median changes in outcomes (and bootstrap confidence intervals) among groups of studies that shared specific features of interest were chosen to analyse the effectiveness of included interventions. Main results: Fifty-one studies were included. They used three different models, namely case management, shared care, and interdisciplinary teams. Six additional interventional strategies were used besides these models: (1) patient-held record, (2) telephone follow-up, (3) communication and case discussion between distant healthcare professionals, (4) change in medical record system, (5) care protocols, directives and guidelines, and (6) coordination of assessments and treatment. Based on the median effect size estimates, no significant difference in patient health-related outcomes was found between patients assigned to interventions and those assigned to usual care. A limited number of studies reported psychological health, satisfaction of providers, or process of care measures. However, they could not be regrouped to calculate median effect size estimates because of a high heterogeneity among studies. Authors' conclusions: Results from this Cochrane review do not allow us to conclude on the effectiveness of included interventions to improve continuity of care on patient, healthcare provider or process of care outcomes. Future research should evaluate interventions that target an improvement in continuity as their primary objective and describe these interventions with the categories proposed in this review. Also of importance, continuity measures should be validated with persons with cancer who have been followed in various settings.

Ballini L, Negro A, Maltoni S, Vignatelli L, Flodgren G, Simera I, et al. **Interventions to reduce waiting times for elective procedures**. Cochrane Database of Systematic Reviews John Wiley & Sons, Ltd; 2015. Abstract: Background: Long waiting times for elective healthcare procedures may cause distress among patients, may have adverse health consequences and may be perceived as inappropriate delivery and planning of health care. Objectives: To assess the effectiveness of interventions aimed at reducing waiting times for elective care, both diagnostic and therapeutic. Search methods: We searched the following electronic databases: Cochrane Effective Practice and Organisation of Care (EPOC) Group Specialised Register, the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE (1946-), EMBASE (1947-), the Cumulative Index to Nursing and Allied Health Literature (CINAHL), ABI Inform, the Canadian Research Index, the Science, Social Sciences and Humanities Citation Indexes, a series of databases via Proquest: Dissertations & Theses (including UK & Ireland), EconLit, PAIS (Public Affairs International), Political Science Collection, Nursing Collection, Sociological Abstracts, Social Services Abstracts and Worldwide Political Science Abstracts. We sought related reviews by searching the Cochrane Database of Systematic Reviews and the Database of Abstracts of Reviews of Effectiveness (DARE). We searched trial registries, as well as grey literature sites and reference lists of relevant articles. Selection criteria: We considered randomised controlled trials (RCTs), controlled before-after studies (CBAs) and interrupted time series (ITS) designs that met EPOC minimum criteria and evaluated the effectiveness of any intervention aimed at reducing waiting times for any type of elective procedure. We considered studies reporting one or more

of the following outcomes: number or proportion of participants whose waiting times were above or below a specific time threshold, or participants' mean or median waiting times. Comparators could include any type of active intervention or standard practice. Data collection and analysis: Two review authors independently extracted data from, and assessed risk of bias of, each included study, using a standardised form and the EPOC 'Risk of bias' tool. They classified interventions as follows: interventions aimed at (1) rationing and/or prioritising demand, (2) expanding capacity, or (3) restructuring the intake assessment/referral process. For RCTs when available, we reported preintervention and postintervention values of outcome for intervention and control groups, and we calculated the absolute change from baseline or the effect size with 95% confidence interval (CI). We reanalysed ITS studies that had been inappropriately analysed using segmented time-series regression, and obtained estimates for regression coefficients corresponding to two standardised effect sizes: change in level and change in slope. Main results: Eight studies met our inclusion criteria: three RCTs and five ITS studies involving a total of 135 general practices/primary care clinics, seven hospitals and one outpatient clinic. The studies were heterogeneous in terms of types of interventions, elective procedures and clinical conditions; this made meta-analysis unfeasible. One ITS study evaluating prioritisation of demand through a system for streamlining elective surgery services reduced the number of semi-urgent participants waiting longer than the recommended time (< 90 days) by 28 participants/mo, while no effects were found for urgent (< 30 days) versus non-urgent participants (< 365 days).Interventions aimed at restructuring the intake assessment/referral process were evaluated in seven studies. Four studies (two RCTs and two ITSs) evaluated open access, or direct booking/referral: One RCT, which showed that open access to laparoscopic sterilisation reduced waiting times, had very high attrition (87%); the other RCT showed that open access to investigative services reduced waiting times (30%) for participants with lower urinary tract syndrome (LUTS) but had no effect on waiting times for participants with microscopic haematuria. In one ITS study, same-day scheduling for paediatric health clinic appointments reduced waiting times (irect reduction of 25.2 days, and thereafter a decrease of 3.03 days per month), while another ITS study showed no effect of a direct booking system on proportions of participants receiving a colposcopy appointment within the recommended time. One RCT and one ITS showed no effect of distant consultancy (instant photography for dermatological conditions and telemedicine for ear nose throat (ENT) conditions) on waiting times; another ITS study showed no effect of a pooled waiting list on the number of participants waiting for uncomplicated spinal surgery. Overall quality of the evidence for all outcomes, assessed using the GRADE (Grades of Recommendation, Assessment, Development and Evaluation) tool, ranged from low to very low. We found no studies evaluating interventions to increase capacity or to ration demand. Authors' conclusions: As only a handful of low-quality studies are presently available, we cannot draw any firm conclusions about the effectiveness of the evaluated interventions in reducing waiting times. However, interventions involving the provision of more accessible services (open access or direct booking/referral) show some promise.

Bassi J, Lau F. **Measuring value for money: A scoping review on economic evaluation of health information systems**. J Am Med Inform Assoc 2013;20(4):792-801.
Abstract: Objective: To explore how key components of economic evaluations have been included in evaluations of health information systems (HIS), to determine the state of knowledge on value for money for HIS, and provide guidance for future evaluations. Materials and methods: We searched databases, previously collected papers, and references for relevant papers published from January 2000 to June 2012. For selection, papers had to: be a primary study; involve a computerized system for health information processing, decision support, or management reporting; and include an economic evaluation. Data on study design and economic evaluation methods were extracted and analyzed. Results:

Forty-two papers were selected and 33 were deemed high quality (scores > 8/10) for further analysis. These included 12 economic analyses, five input cost analyses, and 16 cost-related outcome analyses. For HIS types, there were seven primary care electronic medical records, six computerized provider order entry systems, five medication management systems, five immunization information systems, four institutional information systems, three disease management systems, two clinical documentation systems, and one health information exchange network. In terms of value for money, 23 papers reported positive findings, eight were inconclusive, and two were negative. Conclusions: We found a wide range of economic evaluation papers that were based on different assumptions, methods, and metrics. There is some evidence of value for money in selected healthcare organizations and HIS types. However, caution is needed when generalizing these findings. Better reporting of economic evaluation studies is needed to compare findings and build on the existing evidence base we identified.

Braaf S, Manias E, Riley R. **The role of documents and documentation in communication failure across the perioperative pathway. A literature review**. Int J Nurs Stud 2011;48(8):1024-1038. Abstract: Objective: Communication practices of healthcare professionals have been strongly implicated in the cascade of events that unfold into poor outcomes for surgical patients. The purpose of this paper is to explore the role of documents and documentation in communication failure among healthcare professionals across the perioperative pathway. The perioperative pathway consists of 3 interconnecting, but geographically distinct domains: preoperative, intraoperative and postoperative. Design: A comprehensive search of the literature was undertaken to provide a focused analysis and appraisal of past research. Data sources: Electronic databases searched included the Cochrane Database of Systematic Reviews, the Cumulative Index of Nursing and Allied Health Literature (CINAHL), Medline and PsycINFO from 1990 to end February 2011. Additionally, references of retrieved articles were manually examined for papers not revealed via electronic searches. Review methods: Content analysis was used to draw out major themes and summarise the information. Results: Fifty-nine papers were selected based on their relevance to the topic. The results highlight that documentation such as surgeons' operation notes, anaesthetists' records and nurses' perioperative notes, deficient in the areas of design, quality, accuracy and function, contributed to the development of communication failure among healthcare professionals across the perioperative pathway. The consequences of communication failure attributable to documentation ranged from inefficiency, delays and increased workload, through to serious adverse patient events such as wrong site surgery. Documents that involve the coordination of verbal communication of multidisciplinary surgical teams, such as preoperative checklists, also influenced communication and surgical patient outcomes. Conclusions: Effective communication among healthcare professionals is vital to the delivery of safe patient care. Multiple documents utilised across the perioperative pathway have a critical role in the communication of information essential to the immediate and ongoing care of surgical patients. Failure in the communicative function of documents and documentation impedes the transfer of information and contributes to the cascade of events that results in compromised patient safety and potentially adverse patient outcomes. © 2011.

Callen JL, Westbrook JI, Georgiou A, Li J. **Failure to follow-up test results for ambulatory patients: A systematic review**. J Gen Intern Med 2012;27(10):1334-1348.
Abstract: BACKGROUND: Serious lapses in patient care result from failure to follow-up test results. OBJECTIVE: To systematically review evidence quantifying the extent of failure to follow-up test results and the impact for ambulatory patients. DATA SOURCES: Medline, CINAHL, Embase, Inspec and the Cochrane Database were searched for Englishlanguage literature from 1995 to 2010. STUDY SELECTION: Studies which provided documented

quantitative evidence of the number of tests not followed up for patients attending ambulatory settings including: outpatient clinics, academic medical or community health centres, or primary care practices. DATA EXTRACTION: Four reviewers independently screened 768 articles. RESULTS: Nineteen studies met the inclusion criteria and reported wide variation in the extent of tests not followed-up: 6.8% (79/1163) to 62% (125/202) for laboratory tests; 1.0% (4/395) to 35.7% (45/126) for radiology. The impact on patient outcomes included missed cancer diagnoses. Test management practices varied between settings with many individuals involved in the process. There were few guidelines regarding responsibility for patient notification and follow-up. Quantitative evidence of the effectiveness of electronic test management systems was limited although there was a general trend towards improved test follow-up when electronic systems were used. LIMITATIONS: Most studies used medical record reviews; hence evidence of follow-up action relied upon documentation in the medical record. All studies were conducted in the US so care should be taken in generalising findings to other countries. CONCLUSIONS: Failure to follow-up test results is an important safety concern which requires urgent attention. Solutions should be multifaceted and include: policies relating to responsibility, timing and process of notification; integrated information and communication technologies facilitating communication; and consideration of the multidisciplinary nature of the process and the role of the patient. It is essential that evaluations of interventions are undertaken and solutions integrated into the work and context of ambulatory care delivery. © The Author(s) 2011.

Clay-Williams R, Nosrati H, Cunningham FC, Hillman K, Braithwaite J. **Do large-scale hospital- and system-wide interventions improve patient outcomes: a systematic review**. BMC Health Serv Res 2014;14:369. Abstract: BACKGROUND: While health care services are beginning to implement system-wide patient safety interventions, evidence on the efficacy of these interventions is sparse. We know that uptake can be variable, but we do not know the factors that affect uptake or how the interventions establish change and, in particular, whether they influence patient outcomes. We conducted a systematic review to identify how organisational and cultural factors mediate or are mediated by hospital-wide interventions, and to assess the effects of those factors on patient outcomes.
METHODS: A systematic review was conducted and reported in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Database searches were conducted using MEDLINE from 1946, CINAHL from 1991, EMBASE from 1947, Web of Science from 1934, PsycINFO from 1967, and Global Health from 1910 to September 2012. The Lancet, JAMA, BMJ, BMJ Quality and Safety, The New England Journal of Medicine and Implementation Science were also hand searched for relevant studies published over the last 5 years. Eligible studies were required to focus on organisational determinants of hospital- and system-wide interventions, and to provide patient outcome data before and after implementation of the intervention. Empirical, peer-reviewed studies reporting randomised and non-randomised controlled trials, observational, and controlled before and after studies were included in the review.
RESULTS: Six studies met the inclusion criteria. Improved outcomes were observed for studies where outcomes were measured at least two years after the intervention. Associations between organisational factors, intervention success and patient outcomes were undetermined: organisational culture and patient outcomes were rarely measured together, and measures for culture and outcome were not standardised.
CONCLUSIONS: Common findings show the difficulty of introducing large-scale interventions, and that effective leadership and clinical champions, adequate financial and educational resources, and dedicated promotional activities appear to be common factors in successful system-wide change. The protocol has been registered in the international prospective register of systematic reviews, PROSPERO (Registration No. CRD42103003050).

Collins SA, Stein DM, Vawdrey DK, Stetson PD, Bakken S. **Content overlap in nurse and**

physician handoff artifacts and the potential role of electronic health records: a systematic review. Journal of Biomedical Informatics 2011;44(4):704-712. Abstract: PURPOSE: The aims of this systematic review were: (1) to analyze the content overlap between nurse and physician hospital-based handoff documentation for the purpose of developing a list of interdisciplinary handoff information for use in the future development of shared and tailored computer-based handoff tools, and (2) to evaluate the utility of the Continuity of Care Document (CCD) standard as a framework for organizing hospital-based handoff information for use in electronic health records (EHRs).
METHODS: We searched PubMed for studies published through July 2010 containing the indexed terms: handoff(s), hand-off, handover(s), shift-report, shift report, signout, and sign-out. Original, hospital-based studies of acute care nursing or physician handoff were included. Handoff information content was organized into lists of nursing, physician, and interdisciplinary handoff information elements. These information element lists were organized using CCD sections, with additional sections being added as needed.
RESULTS: Analysis of 36 studies resulted in a total of 95 handoff information elements. Forty-six percent (44/95) of the information overlapped between the nurse and physician handoff lists. Thirty-six percent (34/95) were specific to the nursing list and 18% (17/95) were specific to the physician list. The CCD standard was useful for categorizing 80% of the terms in the lists and 12 category names were developed for the remaining 20%.
CONCLUSION: Standardized interdisciplinary, nursing-specific, and physician-specific handoff information elements that are organized around the CCD standard and incorporated into EHRs in a structured narrative format may increase the consistency of data shared across all handoffs, facilitate the establishment of common ground, and increase interdisciplinary communication.

Cowan L. **Literature review and risk mitigation strategy for unintended consequences of computerized physician order entry**. Nurs Econ 2013;31(1):27-31, 11. Abstract: Computerized physician order entry (CPOE) is a form of patient management health technology software used for providers to enter medical orders into a computer system. CPOE is a health care solution used to improve patient safety and quality of care, decrease costs, and reduce the risk of medical errors. However, there are unintended consequences to electronic health records that can actually cause an increase in medical errors. Two areas of concern that risk management practitioners need to monitor and analyze are the effects of CPOE on nurse-physician communication and operational workflows. A strategic proactive plan will reduce the likelihood of adverse events, specifically medication errors. Providers and nurses will require focused education on effective communication strategies and leadership will need to promote a culture of safety.

Eslami S, de Keizer NF, Abu-Hanna A. **The impact of computerized physician medication order entry in hospitalized patients--a systematic review**. Int J Med Inform 2008;77(6):365-376. Abstract: OBJECTIVE: To identify all published studies evaluating computerized physician order entry (CPOE) in the inpatient setting and uniformly classify these studies on outcome measure and study design.
DATA SOURCES: All studies that evaluated the effect of CPOE on outcomes pertaining to the medication process in inpatients were electronically searched in MEDLINE (1966 to August 2006), EMBASE (1980 to August 2006) and the Cochrane library. In addition, the bibliographies of retrieved articles were manually searched. Articles were selected if one of their main objectives was CPOE evaluation in an inpatient setting.
REVIEW METHOD: Identified titles and abstracts were independently screened by three reviewers to determine eligibility for further review.
RESULTS: We found 67 articles, which included articles on CPOE evaluation on some outcome at the time of ordering. Most papers evaluated multiple outcome measures. The outcome measures were clustered in the following categories: adherence (n=22); alerts

and appropriateness of alerts (n=7); safety (n=21); time (n=7); costs and (organizational) efficiency (n=23); and satisfaction, usage and usability (n=10). Most studies used a before-after design (n=35) followed by observational studies (n=24) and randomized controlled trials (n=8).
CONCLUSION: The impact of CPOE systems was especially positive in the category adherence to guidelines, but also to some extent in alerts and appropriateness of alerts; costs and organizational efficiency; and satisfaction and usability. Although on average, there seems to be a positive effect of CPOE on safety, studies tended to be non-randomized and were focused on medication error rates, not powered to detect a difference in adverse drug event rates. Some recent studies suggested that errors, adverse drug events (ADEs) and even mortality increased after CPOE implementation. Only in the category time the impact has been shown to be negative, but this only refers to the physician's time, not the net time. Except for safety, on the whole spectrum of outcomes, results of RCT studies were in line with non-RCT study results. [References: 92]

Fairman KA, Curtiss FR. **Lessons learned from randomized trials and recent experience with health information technology: promising interventions meet real-world patient care**. J Manag Care Pharm 2010;16(9):718-728.

Finkelstein J, Knight A, Marinopoulos S, Gibbons MC, Berger Z, Aboumatar H, et al. **Enabling patient-centered care through health information technology**. Evidence Report/Technology Assessment 2012 (206):1-1531. Abstract: OBJECTIVES: The main objective of the report is to review the evidence on the impact of health information technology (IT) that supports patient-centered care (PCC) on: health care processes; clinical outcomes; intermediate outcomes (patient or provider satisfaction, health knowledge and behavior, and cost); responsiveness to needs and preferences of patients; shared decisionmaking and patient-clinician communication; and access to information. Additional objectives were to identify barriers and facilitators for using health IT to deliver PCC, and to identify gaps in evidence and information needed by patients, providers, payers, and policymakers.
DATA SOURCES: MEDLINE, Embase, Cochrane Library, Scopus, Cumulative Index to Nursing and Allied Health Literature, PsycINFO, INSPEC, and Compendex databases through July 31, 2010.
METHODS: Paired members of our team reviewed citations to identify randomized controlled trials of PCC-related health IT interventions and studies that addressed barriers and facilitators for health IT for delivery of PCC. Independent assessors rated studies for quality. Paired reviewers abstracted data.
RESULTS: The search identified 327 eligible articles, including 184 articles on the impact of health IT applications implemented to support PCC and 206 articles addressing barriers or facilitators for such health IT applications. Sixty-three articles addressed both questions. The study results suggested positive effects of PCC-related health IT interventions on health care process outcomes, disease-specific clinical outcomes (for diabetes mellitus, heart disease, cancer, and other health conditions), intermediate outcomes, responsiveness to the needs and preferences of patients, shared decisionmaking, patient-clinician communication, and access to medical information. Studies reported a number of barriers and facilitators for using health IT applications to enable PCC. Barriers included: lack of usability; problems with access to the health IT application due to older age, low income, education, cognitive impairment, and other factors; low computer literacy in patients and clinicians; insufficient basic formal training in health IT applications; physicians' concerns about more work; workflow issues; problems related to new system implementation, including concerns about confidentiality of patient information; depersonalization; incom-

patibility with current health care practices; lack of standardization; and problems with reimbursement. Facilitators for the utilization of health IT included ease of use, perceived usefulness, efficiency of use, availability of support, comfort in use, and site location. CONCLUSIONS: Despite marked heterogeneity in study characteristics and quality, substantial evidence exists confirming that health IT applications with PCC-related components have a positive effect on health care outcomes. positive effect on health care outcomes.

Fischer SH, Tjia J, Field TS. **Impact of health information technology interventions to improve medication laboratory monitoring for ambulatory patients: a systematic review**. J Am Med Inform Assoc 2010;17(6):631-636.
Abstract: Medication errors are a major source of morbidity and mortality. Inadequate laboratory monitoring of high-risk medications after initial prescription is a medical error that contributes to preventable adverse drug events. Health information technology (HIT)-based clinical decision support may improve patient safety by improving the laboratory monitoring of high-risk medications, but the effectiveness of such interventions is unclear. Therefore, the authors conducted a systematic review to identify studies that evaluate the independent effect of HIT interventions on improving laboratory monitoring for high-risk medications in the ambulatory setting using a Medline search from January 1, 1980 through January 1, 2009 and a manual review of relevant bibliographies. All anticoagulation monitoring studies were excluded. Eight articles met the inclusion criteria, including six randomized controlled trials and two pre-post intervention studies. Six of the studies were conducted in two large, integrated healthcare delivery systems in the USA. Overall, five of the eight studies reported statistically significant, but small, improvements in laboratory monitoring; only half of the randomized controlled trials reported statistically significant improvements. Studies that found no improvement were more likely to have used analytic strategies that addressed clustering and confounding. Whether HIT improves laboratory monitoring of certain high-risk medications for ambulatory patients remains unclear, and further research is needed to clarify this important question.

Fontaine P, Ross SE, Zink T, Schilling LM. **Systematic review of health information exchange in primary care practices**. J Am Board Fam Med 2010;23(5):655-670.
Abstract: Background: Unprecedented federal interest and funding are focused on secure, standardized, electronic transfer of health information among health care organizations, termed health information exchange (HIE). The stated goals are improvements in health care quality, efficiency, and cost. Ambulatory primary care practices are essential to this process; however, the factors that motivate them to participate in HIE are not well studied, particularly among small practices. Methods: We conducted a systematic review of the literature about HIE participation from January 1990 through mid-September 2008 to identify peer-reviewed and non-peer-reviewed publications in bibliographic databases and websites. Reviewers abstracted each publication for predetermined key issues, including stakeholder participation in HIE, and the benefits, barriers, and overall value to primary care practices. We identified themes within each key issue, then grouped themes and identified supporting examples for analysis. Results: One hundred and sixteen peer-reviewed, non-peer-reviewed, and web publications were retrieved, and 61 met inclusion criteria. Of 39 peer-reviewed publications, one-half reported original research. Among themes of cost savings, workflow efficiency, and quality, the only benefits to be reliably documented were those regarding efficiency, including improved access to test results and other data from outside the practice and decreased staff time for handling referrals and claims processing. Barriers included cost, privacy and liability concerns, organizational characteristics, and technical barriers. A positive return on investment has not been documented. Conclusions: The potential for HIE to reduce costs and improve the quality of

health care in ambulatory primary care practices is well recognized but needs further empiric substantiation.

Foulon V, Claeys C, De Lepeleire J, Chevalier P, Desplenter F, De Winter S, et al. **How to improve the continuity of pharmacotherapy at hospital admission and discharge. [Dutch]**. Farmaceutisch Tijdschrift voor Belgie 2010;87(4):116-120.
Abstract: The continuity of pharmacotherapy is of vital importance when patients move from one health care setting to another. Unfortunately, this continuity is not always guaranteed. The aim of this study is to propose solutions to enhance the continuity of pharmacotherapy at hospital admission and discharge. The study consists of a systematic review of the international literature and an analysis of seamless care initiatives in seven selected countries; a summary of Belgian data on problems as well as solutions with regard to continuity of care; a quantification of the extent of medication changes as a result of a hospital stay in Belgium; and a qualitative analysis of the perception of Belgian health care professionals (HCPs) on approaches to improve seamless care. The literature review yielded 15 papers of sufficient quality. However, this review did not generate definitive conclusions on the clinical impact and the cost-effectiveness of interventions aiming to enhance the continuity of pharmacotherapy. The most important initiatives that have been put in practice in foreign countries include the development and implementation of guidelines for HCPs; national information campaigns; education of HCPs; and the development of information technologies as to share patient and prescription data between settings of care. For Belgium, 66 seamless care initiatives were identified. The high number and variety of projects show the interest for this topic as well as the involvement of various HCPs from diverse settings in the development of solutions. Based on this research, and the solutions discussed in the focus groups, the following elements are proposed to enhance the continuity of pharmacotherapy: a national guideline governing the continuity of pharmacotherapy; a national campaign to sensitize HCPs and patients in this area; the availability of a comprehensive and up to date medication list for each patient; and electronic healthcare infrastructure that facilitates sharing of information.

Foy R, Hempel S, Rubenstein L, Suttorp M, Seelig M, Shanman R, et al. **Meta-analysis: effect of interactive communication between collaborating primary care physicians and specialists**. Ann Intern Med 2010;152(4):247-258.
Abstract: To evaluate the effectiveness of interactive communication between collaborating primary care physicians and specialists on outcomes relating to patients in ambulatory care.
PubMed, PsycINFO, EMBASE, CINAHL, Cochrane Database of Systematic Reviews, DARE and Web of Science were searched from inception to June 2008 without language restriction. Search terms were reported. References lists of relevant articles and reviews were scanned for additional studies.
A seven-item checklist was used to score the internal validity of studies covering: randomisation; allocation concealment; sample size calculation; blinding; reliability of outcome measures; completeness of follow-up; and appropriateness of analysis. A six-item checklist was used to score: external validity; covering representativeness of study population; replicability and sustainability of the intervention; appropriateness of outcome measures; long-term follow-up; and process evaluation. Studies were scored according to the number of criteria met.The authors did not state how many reviewers performed the quality assessment.
Data were extracted to enable the calculation of standardised mean differences (SMDs) and 95% confidence intervals (CI). Data were also extracted on core features of the interventions, and any co-interventions.One reviewer extracted the data, and this was checked by a second reviewer. Disagreements were resolved by discussion, and by reference to other reviewers.

Twenty-three studies were included in the review. There were 11 RCTs (2,355 patients), of which six were cluster-randomised; one non-RCT (181 patients); three controlled before-after studies (978 patients); and eight uncontrolled before-after studies (2,415 patients). The internal and external validity of RCTs was considered to be moderate (median internal validity score 5). The median scores for non-RCTs were 3 to 4 for internal validity, and 3 for external validity. Follow-up (where reported) ranged from two months to 36 months (median 9.5 months). There was no consistent evidence of publication bias.In studies of patients with psychiatric conditions, the pooled analysis of 11 RCTs showed that interactive communication produced small to moderate, but statistically significant, improvements in patient depression outcomes (SMD -0.41, 95% CI -0.73 to -0.10). A further seven non-randomised studies showed a similar improvement in patient depression outcomes (SMD -0.47, 95% CI -0.84 to -0.09). In studies involving patients with diabetes, the pooled analysis of five non-randomised studies showed that interactive communication resulted in moderate, statistically significant improvements in haemoglobin A1c (SMD -0.64, 95% CI -0.93 to -0.34). There was high heterogeneity across all analyses (I2=84.9% to 91.7%).Sensitivity analysis did not materially alter the main findings. Meta-regression analysis showed that interventions that included measures to enhance the quality of information exchange produced larger effects on patient outcomes than those that did not (SMD -0.84 versus -0.27). Effect sizes were similar in integrated and non-integrated health care systems.
A potential role was found for interactive communication for improving the effectiveness of collaboration between primary care physicians and specialists.
The review question was clear and inclusion criteria were stated for all aspects, except outcomes. Outcome measures were chosen from included studies in a manner which suggested that selection bias was minimised. The search strategy included several relevant sources and attempts were made to address language bias. It was not clear to what extent unpublished material was sought, so relevant studies may have been missed. It appeared that appropriate validity assessment criteria were chosen for the included study designs. The selection of studies was carried out with sufficient attempts to minimise reviewer error and bias; this was partially the case in the process of data extraction, but it was not clear how the validity assessment was performed. Study characteristics were provided in detail, and the chosen method of synthesis appeared to be appropriate in the presence of high heterogeneity which was explored. The authors drew attention to limitations of the review, including narrow generalisability and inability to distinguish the effective elements of multifaceted interventions. The review was largely well-conducted, and the authors' cautious conclusion is likely to be reliable.
Practice: The authors stated that investments to promote interactive communication between primary care physicians and specialists may offer equal or more benefit than many clinical interventions. Research: The authors stated that further studies are needed to explore the key variants necessary for the development of structured interaction between primary care physicians and specialists across other clinical disciplines.

Georgiou A, Prgomet M, Markewycz A, Adams E, Westbrook JI. **The impact of computerized provider order entry systems on medical-imaging services: a systematic review**. J Am Med Inform Assoc 2011;18(3):335-340. Abstract: BACKGROUND: Computerized provider order entry (CPOE) systems have been strongly promoted as a means to improve the quality and efficiency of healthcare.
METHODS: This systematic review aimed to assess the evidence of the impact of CPOE on medical-imaging services and patient outcomes.
RESULTS: Fourteen studies met the inclusion criteria, most of which (10/14) used a pre-/postintervention comparison design. Eight studies demonstrated benefits, such as decreased test utilization, associated with decision-support systems promoting adherence to test ordering guidelines. Three studies evaluating medical-imaging ordering and reporting times showed statistically significant decreases in turnaround times.

CONCLUSIONS: The findings reveal the potential for CPOE to contribute to significant efficiency and effectiveness gains in imaging services. The diversity and scope of the research evidence can be strengthened through increased attention to the circumstances and mechanisms that contribute to the success (or otherwise) of CPOE and its contribution to the enhancement of patient care delivery.

Georgiou A, Prgomet M, Paoloni R, Creswick N, Hordern A, Walter S, et al. **The effect of computerized provider order entry systems on clinical care and work processes in emergency departments: a systematic review of the quantitative literature**. Ann Emerg Med 2013;61(6):644-653.e616.

Abstract: STUDY OBJECTIVE: We undertake a systematic review of the quantitative literature related to the effect of computerized provider order entry systems in the emergency department (ED).

METHODS: We searched MEDLINE, EMBASE, Inspec, CINAHL, and CPOE.org for English-language studies published between January 1990 and May 2011.

RESULTS: We identified 1,063 articles, of which 22 met our inclusion criteria. Sixteen used a pre/post design; 2 were randomized controlled trials. Twelve studies reported outcomes related to patient flow/clinical work, 7 examined decision support systems, and 6 reported effects on patient safety. There were no studies that measured decision support systems and its effect on patient flow/clinical work. Computerized provider order entry was associated with an increase in time spent on computers (up to 16.2% for nurses and 11.3% for physicians), with no significant change in time spent on patient care. Computerized provider order entry with decision support systems was related to significant decreases in prescribing errors (ranging from 17 to 201 errors per 100 orders), potential adverse drug events (0.9 per 100 orders), and prescribing of excessive dosages (31% decrease for a targeted set of renal disease medications).

CONCLUSION: There are tangible benefits associated with computerized provider order entry/decision support systems in the ED environment. Nevertheless, when considered as part of a framework of technical, clinical, and organizational components of the ED, the evidence base is neither consistent nor comprehensive. Multimethod research approaches (including qualitative research) can contribute to understanding of the multiple dimensions of ED care delivery, not as separate entities but as essential components of a highly integrated system of care.

Hawley G, Janamian T, Jackson C, Wilkinson SA. **In a maternity shared-care environment, what do we know about the paper hand-held and electronic health record: A systematic literature review**. BMC Pregnancy Childbirth 2014;14(1).

Abstract: Background: The paper hand-held record (PHR) has been widely used as a tool to facilitate communication between health care providers and a pregnant woman. Since its inception in the 1950s, it has been described as a successful initiative, evolving to meet the needs of communities and their providers. Increasingly, the electronic health record (EHR) has dominated the healthcare arena and the maternity general practice shared-care arrangement seems to have adopted this initiative. A systematic review was conducted to determine perspectives of the PHR and the EHR with regards to data completeness; experiences of users and integration of care between women and health care providers.

Method: A literature search was conducted that included papers from 1985 to 2012. Studies were chosen if they fulfilled the inclusion criteria, reporting on: data completeness; experiences of users and integration of care between women and health care providers. Papers were extracted by one reviewer in consultation with two reviewers with expertise in maternity e-health and independently assessed for quality. Results: A total of 43 papers were identified for the review, from an initial 6,816 potentially relevant publications. No papers were found that reported on data completeness in a maternity PHR or a maternity

EHR, in a shared-care setting. Women described the PHR as important to their antenatal care and had a generally positive perception of using an EHR. Hospital clinicians reported generally positive experiences using a PHR, while both positive and negative impressions were found using an EHR. The few papers describing the use of the PHR and EHR by community clinicians were also divergent and inconclusive with regards to their experiences. In a general practice shared-care model, the PHR is a valuable tool for integration between the woman and the health care provider. While the EHR is an ideal initiative in the maternity setting, facilitating referrals and communication, there are issues of fragmentation and continued paper use. Conclusions: There was a surprising gap in knowledge surrounding data completeness on maternity PHRs or EHRs. There is also a paucity of available impressions from community clinicians using both forms of the records. © 2014 Hawley et al.; licensee BioMed Central Ltd.

Hayes, Inc. **Computerized provider order entry for medications: outpatients (Structured abstract)**. Health Technology Assessment Database HAYES, Inc; 2009.

Hayward GL, Parnes AJ, Simon SR. **Using health information technology to improve drug monitoring: a systematic review**. Pharmacoepidemiol Drug Saf 2009;18(12):1232-1237.
Abstract: PURPOSE: To conduct a systematic review of current evidence regarding the use of health information technology (HIT) interventions to improve drug monitoring in ambulatory care.
METHODS: We searched PubMed, CINAHL, the Cochrane Library, and other computerized databases from 1 January 1998 to 30 June 2008 using the key words "drug monitoring," "medical records systems, computerized," "ambulatory care," and "outpatients." We manually reviewed reference lists of articles identified through computer searches and asked experts in the field to review our search strategy and results for completeness.
RESULTS: Seven relevant studies were identified. Four of these studies assessed real-time interventions that used alerts to physicians at the time of medication ordering to ensure adequate monitoring, only one of which showed an improvement in monitoring. Of three studies using HIT outside the physician encounter, two suggested some improvement in monitoring rates. Methodological limitations were apparent in all studies identified.
CONCLUSIONS: Few studies have assessed the effectiveness of HIT interventions to improve drug monitoring, and among them, there is no clear consensus regarding the most consistently effective approaches to reducing drug monitoring errors. There is a clear need for well designed randomized trials to evaluate possible interventions to reduce drug monitoring errors. Such studies should incorporate health outcomes and detailed cost analyses to further characterize the feasibility of successful interventions.Copyright (c) 2009 John Wiley & Sons, Ltd. [References: 29]

Hesselink G, Schoonhoven L, Barach P, Spijker A, Gademan P, Kalkman C, et al. **Improving patient handovers from hospital to primary care: a systematic review**. Ann Intern Med 2012;157(6):417-428.
Abstract: BACKGROUND: Evidence shows that suboptimum handovers at hospital discharge lead to increased rehospitalizations and decreased quality of health care.
PURPOSE: To systematically review interventions that aim to improve patient discharge from hospital to primary care.
DATA SOURCES: PubMed, CINAHL, PsycInfo, the Cochrane Library, and EMBASE were searched for studies published between January 1990 and March 2011.
STUDY SELECTION: Randomized, controlled trials of interventions that aimed to improve handovers between hospital and primary care providers at hospital discharge.
DATA EXTRACTION: Two reviewers independently abstracted data on study objectives, setting and design, intervention characteristics, and outcomes. Studies were categorized

according to methodological quality, sample size, intervention characteristics, outcome, statistical significance, and direction of effects.
DATA SYNTHESIS: Of the 36 included studies, 25 (69.4%) had statistically significant effects in favor of the intervention group and 34 (94.4%) described multicomponent interventions. Effective interventions included medication reconciliation; electronic tools to facilitate quick, clear, and structured summary generation; discharge planning; shared involvement in follow-up by hospital and community care providers; use of electronic discharge notifications; and Web-based access to discharge information for general practitioners. Statistically significant effects were mostly found in reducing hospital use (for example, rehospitalizations), improvement of continuity of care (for example, accurate discharge information), and improvement of patient status after discharge (for example, satisfaction).
LIMITATIONS: Heterogeneity of the interventions and study characteristics made meta-analysis impossible. Most studies had diffuse aims and poor descriptions of the specific intervention components.
CONCLUSION: Many interventions have positive effects on patient care. However, given the complexity of interventions and outcome measures, the literature does not permit firm conclusions about which interventions have these effects.
PRIMARY FUNDING SOURCE: The European Union, the Framework Programme of the European Commission.

Hincapie A, Warholak T. **The impact of health information exchange on health outcomes**. Appl Clin Inform 2011;2(4):499-507.
Abstract: BACKGROUND AND OBJECTIVE: Healthcare professionals, industry and policy makers have identified Health Information Exchange (HIE) as a solution to improve patient safety and overall quality of care. The potential benefits of HIE on healthcare have fostered its implementation and adoption in the United States. However, there is a dearth of publications that demonstrate HIE effectiveness. The purpose of this review was to identify and describe evidence of HIE impact on healthcare outcomes.
METHODS: A database search was conducted. The inclusion criteria included original investigations in English that focused on a HIE outcome evaluation. Two independent investigators reviewed the articles. A qualitative coding approach was used to analyze the data.
RESULTS: Out of 207 abstracts retrieved, five articles met the inclusion criteria. Of these, 3 were randomized controlled trials, 1 involved retrospective review of data, and 1 was a prospective study. We found that HIE benefits on healthcare outcomes are still sparsely evaluated, and that among the measurements used to evaluate HIE healthcare utilization is the most widely used.
CONCLUSIONS: Outcomes evaluation is required to give healthcare providers and policy-makers evidence to incorporate in decision-making processes. This review showed a dearth of HIE outcomes data in the published peer reviewed literature so more research in this area is needed. Future HIE evaluations with different levels of interoperability should incorporate a framework that allows a detailed examination of HIE outcomes that are likely to positively affect care.

Jaspers MW, Smeulers M, Vermeulen H, Peute LW. **Effects of clinical decision-support systems on practitioner performance and patient outcomes: a synthesis of high-quality systematic review findings**. J Am Med Inform Assoc 2011;18(3):327-334.
Abstract: OBJECTIVE: To synthesize the literature on clinical decision-support systems' (CDSS) impact on healthcare practitioner performance and patient outcomes.
DESIGN: Literature search on Medline, Embase, Inspec, Cinahl, Cochrane/Dare and analysis of high-quality systematic reviews (SRs) on CDSS in hospital settings. Two-stage inclusion procedure: (1) selection of publications on predefined inclusion criteria; (2) independent

methodological assessment of preincluded SRs by the 11-item measurement tool, AMSTAR. Inclusion of SRs with AMSTAR score 9 or above. SRs were thereafter rated on level of evidence. Each stage was performed by two independent reviewers.
RESULTS: 17 out of 35 preincluded SRs were of high methodological quality and further analyzed. Evidence that CDSS significantly impacted practitioner performance was found in 52 out of 91 unique studies of the 16 SRs examining this effect (57%). Only 25 out of 82 unique studies of the 16 SRs reported evidence that CDSS positively impacted patient outcomes (30%).
CONCLUSIONS: Few studies have found any benefits on patient outcomes, though many of these have been too small in sample size or too short in time to reveal clinically important effects. There is significant evidence that CDSS can positively impact healthcare providers' performance with drug ordering and preventive care reminder systems as most clear examples. These outcomes may be explained by the fact that these types of CDSS require a minimum of patient data that are largely available before the advice is (to be) generated: at the time clinicians make the decisions.

Jones SS, Rudin RS, Perry T, Shekelle PG. **Health information technology: an updated systematic review with a focus on meaningful use**. Ann Intern Med 2014;160(1):48-54.

Abstract: BACKGROUND: Incentives offered by the U.S. government have spurred marked increases in use of health information technology (IT).
PURPOSE: To update previous reviews and examine recent evidence that relates health IT functionalities prescribed in meaningful use regulations to key aspects of health care.
DATA SOURCES: English-language articles in PubMed from January 2010 to August 2013.
STUDY SELECTION: 236 studies, including pre-post and time-series designs and clinical trials that related the use of health IT to quality, safety, or efficiency.
DATA EXTRACTION: Two independent reviewers extracted data on functionality, study outcomes, and context.
DATA SYNTHESIS: Fifty-seven percent of the 236 studies evaluated clinical decision support and computerized provider order entry, whereas other meaningful use functionalities were rarely evaluated. Fifty-six percent of studies reported uniformly positive results, and an additional 21% reported mixed-positive effects. Reporting of context and implementation details was poor, and 61% of studies did not report any contextual details beyond basic information.
LIMITATION: Potential for publication bias, and evaluated health IT systems and outcomes were heterogeneous and incompletely described.
CONCLUSION: Strong evidence supports the use of clinical decision support and computerized provider order entry. However, insufficient reporting of implementation and context of use makes it impossible to determine why some health IT implementations are successful and others are not. The most important improvement that can be made in health IT evaluations is increased reporting of the effects of implementation and context.
PRIMARY FUNDING SOURCE: Office of the National Coordinator.

Kelley TF, Brandon DH, Docherty SL. **Electronic nursing documentation as a strategy to improve quality of patient care**. J Nurs Scholarsh 2011;43(2):154-162.
Abstract: PURPOSE: Electronic health records are expected to improve the quality of care provided to hospitalized patients. For nurses, use of electronic documentation sources becomes highly relevant because this is where they obtain the majority of necessary patient information.
METHODS: An integrative review of the literature examined the relationship between electronic nursing documentation and the quality of care provided to hospitalized patients. Donabedian's quality framework was used to organize empirical literature for review.

RESULTS: To date, the use of electronic nursing documentation to improve patient outcomes remains unclear.
CONCLUSIONS AND IMPLICATIONS: Future research should investigate the day-to-day interactions between nurses and electronic nursing documentation for the provision of quality care to hospitalized patients.
CLINICAL RELEVANCE: The majority of U.S. hospital care units currently use paper-based nursing documentation to exchange patient information for quality care. However, by 2014, all U.S. hospitals are expected to use electronic nursing documentation on patient care units, with the anticipated benefit of improved quality. However, the extent to which electronic nursing documentation improves the quality of care to hospitalized patients remains unknown, in part due to the lack of effective comparisons with paper-based nursing documentation.

Khajouei R, Jaspers MW. **The impact of CPOE medication systems' design aspects on usability, workflow and medication orders: a systematic review**. Methods Inf Med 2010;49(1):3-19.
Abstract: OBJECTIVES: To examine the impact of design aspects of computerized physician order entry (CPOE) systems for medication ordering on usability, physicians' workflow and on medication orders.
METHODS: We systematically searched PubMed, EMBASE and Ovid MEDLINE for articles published from 1986 to 2007. We also evaluated reference lists of reviews and relevant articles captured by our search strategy, and the web-based inventory of evaluation studies in medical informatics 1982-2005. Data about design aspects were extracted from the relevant articles. Identified design aspects were categorized in groups derived from principles for computer screen and dialogue design and user guidance from the International Standard Organization, and if CPOE-specific, from the collected data.
RESULTS: A total of 19 papers met our inclusion criteria. Sixteen studies used qualitative evaluation methods and the rest both qualitative and quantitative. In total 42 CPOE design aspects were identified and categorized in seven groups: 1) documentation and data entry components, 2) alerting, 3) visual clues and icons, 4) drop-down lists and menus, 5) safeguards, 6) screen displays, and 7) auxiliary functions.
CONCLUSIONS: Beside the range of functionalities provided by a CPOE system, their subtle design is important to increase physicians' adoption and to reduce medication errors. This requires continuous evaluations to investigate whether interfaces of CPOE systems follow normal flow of actions in the ordering process and if they are cognitively easy to understand and use for physicians. This paper provides general recommendations for CPOE (re)design based on the characteristics of CPOE design aspects found. [References: 13]

Maenpaa T, Suominen T, Asikainen P, Maass M, Rostila I. **The outcomes of regional healthcare information systems in health care: A review of the research literature**. Int J Med Inform 2009;78(11):757-771.
Abstract: The resulting regional healthcare information systems were expected to have effects and impacts on health care procedures, work practices and treatment outcomes. The aim is to find out how health information systems have been investigated, what has been investigated and what are the outcomes. A systematic review was carried out of the research on the regional health information systems or organizations. The literature search was conducted on four electronic Cinahl Medline, Medline/PubMed and Cochrane. The common type of study design was the survey research and case study, and the data collection was carried out via different methodologies. They found out different types of regional health information systems (RHIS). The systems were heterogeneous and were in different phases of these developments. The RHIS outcomes focused on the five main areas: flow of information, collaboration, process redesign, system usability and organization

culture. The RHIS improved the clinical data access, timely information, and clinical data exchange and improvement in communication and coordination within a region between professionals but also there was inadequate access to patient relevant clinical data. There were differences in organization culture, vision and expectations of leadership and consistency of strategic plan. Nevertheless, there were widespread participation by both healthcare providers and patients.

Millery M, Kukafka R. **Health information technology and quality of health care: Strategies for reducing disparities in underresourced settings**. Med Care Res Rev 2010;67(5):268S-298S.
Abstract: Health information technology (health IT) has potential for facilitating quality improvement and reducing quality disparities found in underresourced settings (URSs). With this systematic literature review, complemented by key informant interviews, the authors sought to identify evidence regarding health IT and quality outcomes in URSs. The review included 105 peer-reviewed studies (2004-2009) in all settings. Only 15 studies included URSs, and 8 focused on URSs. Based on literature across settings, most evidence was available for quality impact of order entry, clinical decision support systems, and computerized reminders. Study designs were predominantly quasi-experimental (37%) or descriptive (35%); 90% of the studies focused on the microsystem level of quality improvement, indicating a need for expanding research into patient experience and organizational and environmental levels. Key informants highlighted organizational partnerships and health IT champions and emphasized that for health IT to have an impact on quality, there must be an organizational culture of quality improvement. © The Author(s) 2010.

Moja L, Kwag KH, Lytras T, Bertizzolo L, Brandt L, Pecoraro V, et al. **Effectiveness of computerized decision support systems linked to electronic health records: a systematic review and meta-analysis**. Am J Public Health 2014;104(12):e12-22.
Abstract: We systematically reviewed randomized controlled trials (RCTs) assessing the effectiveness of computerized decision support systems (CDSSs) featuring rule- or algorithm-based software integrated with electronic health records (EHRs) and evidence-based knowledge. We searched MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, and Cochrane Database of Abstracts of Reviews of Effects. Information on system design, capabilities, acquisition, implementation context, and effects on mortality, morbidity, and economic outcomes were extracted. Twenty-eight RCTs were included. CDSS use did not affect mortality (16 trials, 37395 patients; 2282 deaths; risk ratio [RR]=0.96; 95% confidence interval [CI]=0.85, 1.08; I(2)=41%). A statistically significant effect was evident in the prevention of morbidity, any disease (9 RCTs; 13868 patients; RR=0.82; 95% CI=0.68, 0.99; I(2)=64%), but selective outcome reporting or publication bias cannot be excluded. We observed differences for costs and health service utilization, although these were often small in magnitude. Across clinical settings, new generation CDSSs integrated with EHRs do not affect mortality and might moderately improve morbidity outcomes.

Mollon B, Chong J, Jr., Holbrook AM, Sung M, Thabane L, Foster G. **Features predicting the success of computerized decision support for prescribing: a systematic review of randomized controlled trials**. BMC Med Inform Decis Mak 2009;9:11.
Abstract: BACKGROUND: Computerized decision support systems (CDSS) are believed to have the potential to improve the quality of health care delivery, although results from high quality studies have been mixed. We conducted a systematic review to evaluate whether certain features of prescribing decision support systems (RxCDSS) predict successful implementation, change in provider behaviour, and change in patient outcomes. METHODS: A literature search of Medline, EMBASE, CINAHL and INSPEC databases (earliest entry to June 2008) was conducted to identify randomized controlled trials involving RxCDSS. Each citation was independently assessed by two reviewers for outcomes and 28

predefined system features. Statistical analysis of associations between system features and success of outcomes was planned.
RESULTS: Of 4534 citations returned by the search, 41 met the inclusion criteria. Of these, 37 reported successful system implementations, 25 reported success at changing health care provider behaviour, and 5 noted improvements in patient outcomes. A mean of 17 features per study were mentioned. The statistical analysis could not be completed due primarily to the small number of studies and lack of diversity of outcomes. Descriptive analysis did not confirm any feature to be more prevalent in successful trials relative to unsuccessful ones for implementation, provider behaviour or patient outcomes.
CONCLUSION: While RxCDSSs have the potential to change health care provider behaviour, very few high quality studies show improvement in patient outcomes. Furthermore, the features of the RxCDSS associated with success (or failure) are poorly described, thus making it difficult for system design and implementation to improve. [References: 68]

Nguyen L, Bellucci E, Nguyen LT. **Electronic health records implementation: An evaluation of information system impact and contingency factors**. Int J Med Inform 2014;83(11):779-796.
Abstract: Objective: This paper provides a review of EHR (electronic health record) implementations around the world and reports on findings including benefits and issues associated with EHR implementation. Materials and methods: A systematic literature review was conducted from peer-reviewed scholarly journal publications from the last 10 years (2001-2011). The search was conducted using various publication collections including: Scopus, Embase, Informit, Medline, Proquest Health and Medical Complete. This paper reports on our analysis of previous empirical studies of EHR implementations. We analysed data based on an extension of DeLone and McLean's information system (IS) evaluation framework. The extended framework integrates DeLone and McLean's dimensions, including information quality, system quality, service quality, intention of use and usage, user satisfaction and net benefits, together with contingent dimensions, including systems development, implementation attributes and organisational aspects, as identified by Van der Meijden and colleagues. Results: A mix of evidence-based positive and negative impacts of EHR was found across different evaluation dimensions. In addition, a number of contingent factors were found to contribute to successful implementation of EHR. Limitations: This review does not include white papers or industry surveys, non-English papers, or those published outside the review time period. Conclusion: This review confirms the potential of this technology to aid patient care and clinical documentation; for example, in improved documentation quality, increased administration efficiency, as well as better quality, safety and coordination of care. Common negative impacts include changes to workflow and work disruption. Mixed observations were found on EHR quality, adoption and satisfaction. The review warns future implementers of EHR to carefully undertake the technology implementation exercise. The review also informs healthcare providers of contingent factors that potentially affect EHR development and implementation in an organisational setting. Our findings suggest a lack of socio-technical connectives between the clinician, the patient and the technology in developing and implementing EHR and future developments in patient-accessible EHR. In addition, a synthesis of DeLone and McLean's framework and Van der Meijden and colleagues' contingent factors has been found useful in comprehensively understanding and evaluating EHR implementations.

Nhavoto JA, Gronlund A. **Mobile technologies and geographic information systems to improve health care systems: a literature review**. JMIR MHealth and UHealth 2014;2(2):e21.
Abstract: BACKGROUND: A growing body of research has employed mobile technologies and geographic information systems (GIS) for enhancing health care and health information systems, but there is yet a lack of studies of how these two types of systems are

integrated together into the information infrastructure of an organization so as to provide a basis for data analysis and decision support. Integration of data and technical systems across the organization is necessary for efficient large-scale implementation.
OBJECTIVE: The aim of this paper is to identify how mobile technologies and GIS applications have been used, independently as well as in combination, for improving health care.
METHODS: The electronic databases PubMed, BioMed Central, Wiley Online Library, Scopus, Science Direct, and Web of Science were searched to retrieve English language articles published in international academic journals after 2005. Only articles addressing the use of mobile or GIS technologies and that met a prespecified keyword strategy were selected for review.
RESULTS: A total of 271 articles were selected, among which 220 concerned mobile technologies and 51 GIS. Most articles concern developed countries (198/271, 73.1%), and in particular the United States (81/271, 29.9%), United Kingdom (31/271, 11.4%), and Canada (14/271, 5.2%). Applications of mobile technologies can be categorized by six themes: treatment and disease management, data collection and disease surveillance, health support systems, health promotion and disease prevention, communication between patients and health care providers or among providers, and medical education. GIS applications can be categorized by four themes: disease surveillance, health support systems, health promotion and disease prevention, and communication to or between health care providers. Mobile applications typically focus on using text messaging (short message service, SMS) for communication between patients and health care providers, most prominently reminders and advice to patients. These applications generally have modest benefits and may be appropriate for implementation. Integration of health data using GIS technology also exhibit modest benefits such as improved understanding of the interplay of psychological, social, environmental, area-level, and sociodemographic influences on physical activity. The studies evaluated showed promising results in helping patients treating different illnesses and managing their condition effectively. However, most studies use small sample sizes and short intervention periods, which means limited clinical or statistical significance.
CONCLUSIONS: A vast majority of the papers report positive results, including retention rate, benefits for patients, and economic gains for the health care provider. However, implementation issues are little discussed, which means the reasons for the scarcity of large-scale implementations, which might be expected given the overwhelmingly positive results, are yet unclear. There is also little combination between GIS and mobile technologies. In order for health care processes to be effective they must integrate different kinds of existing technologies and data. Further research and development is necessary to provide integration and better understand implementation issues.

Niazkhani Z, Pirnejad H, Berg M, Aarts J. **The impact of computerized provider order entry systems on inpatient clinical workflow: a literature review**. J Am Med Inform Assoc 2009;16(4):539-549.
Abstract: Previous studies have shown the importance of workflow issues in the implementation of CPOE systems and patient safety practices. To understand the impact of CPOE on clinical workflow, we developed a conceptual framework and conducted a literature search for CPOE evaluations between 1990 and June 2007. Fifty-one publications were identified that disclosed mixed effects of CPOE systems. Among the frequently reported workflow advantages were the legible orders, remote accessibility of the systems, and the shorter order turnaround times. Among the frequently reported disadvantages were the time-consuming and problematic user-system interactions, and the enforcement of a predefined relationship between clinical tasks and between providers. Regarding the diversity of findings in the literature, we conclude that more multi-method research is needed to explore CPOE's multidimensional and collective impact on especially collaborative workflow. [References: 96]

Nuckols TK, Smith-Spangler C, Morton SC, Asch SM, Patel VM, Anderson LJ, et al. **The effectiveness of computerized order entry at reducing preventable adverse drug events and medication errors in hospital settings: a systematic review and meta-analysis (Provisional abstract)**. Database of Abstracts of Reviews of Effects2014. p. 56.

Radley DC, Wasserman MR, Olsho LE, Shoemaker SJ, Spranca MD, Bradshaw B. **Reduction in medication errors in hospitals due to adoption of computerized provider order entry systems**. J Am Med Inform Assoc 2013;20(3):470-476.
Abstract: OBJECTIVE: Medication errors in hospitals are common, expensive, and sometimes harmful to patients. This study's objective was to derive a nationally representative estimate of medication error reduction in hospitals attributable to electronic prescribing through computerized provider order entry (CPOE) systems.
MATERIALS AND METHODS: We conducted a systematic literature review and applied random-effects meta-analytic techniques to derive a summary estimate of the effect of CPOE on medication errors. This pooled estimate was combined with data from the 2006 American Society of Health-System Pharmacists Annual Survey, the 2007 American Hospital Association Annual Survey, and the latter's 2008 Electronic Health Record Adoption Database supplement to estimate the percentage and absolute reduction in medication errors attributable to CPOE.
RESULTS: Processing a prescription drug order through a CPOE system decreases the likelihood of error on that order by 48% (95% CI 41% to 55%). Given this effect size, and the degree of CPOE adoption and use in hospitals in 2008, we estimate a 12.5% reduction in medication errors, or ~17.4 million medication errors averted in the USA in 1 year.
DISCUSSION: Our findings suggest that CPOE can substantially reduce the frequency of medication errors in inpatient acute-care settings; however, it is unclear whether this translates into reduced harm for patients.
CONCLUSIONS: Despite CPOE systems' effectiveness at preventing medication errors, adoption and use in US hospitals remain modest. Current policies to increase CPOE adoption and use will likely prevent millions of additional medication errors each year. Further research is needed to better characterize links to patient harm.

Rahurkar S, Vest JR, Menachemi N. **Despite The Spread Of Health Information Exchange, There Is Little Evidence Of Its Impact On Cost, Use, And Quality Of Care**. Health Aff (Millwood) 2015;34(3):477-483.
Abstract: Health information exchange (HIE), which is the transfer of electronic information such as laboratory results, clinical summaries, and medication lists, is believed to boost efficiency, reduce health care costs, and improve outcomes for patients. Stimulated by federal financial incentives, about two-thirds of hospitals and almost half of physician practices are now engaged in some type of HIE with outside organizations. To determine how HIE has affected such health care measures as cost, service use, and quality, we identified twenty-seven scientific studies, extracted selected characteristics from each, and metaanalyzed these characteristics for trends. Overall, 57 percent of published analyses reported some benefit from HIE. However, articles employing study designs having strong internal validity, such as randomized controlled trials or quasi-experiments, were significantly less likely than others to associate HIE with benefits. Among six articles with strong internal validity, one study reported paradoxical negative effects, three studies found no effect, and two studies reported that HIE led to benefits. Furthermore, these two studies had narrower focuses than the others. Overall, little generalizable evidence currently exists regarding benefits attributable to HIE.

Reckmann MH, Westbrook JI, Koh Y, Lo C, Day RO. **Does computerized provider order**

entry reduce prescribing errors for hospital inpatients? A systematic review. J Am Med Inform Assoc 2009;16(5):613-623.
Abstract: Previous reviews have examined evidence of the impact of CPOE on medication errors, but have used highly variable definitions of "error". We attempted to answer a very focused question, namely, what evidence exists that CPOE systems reduce prescribing errors among hospital inpatients? We identified 13 papers (reporting 12 studies) published between 1998 and 2007. Nine demonstrated a significant reduction in prescribing error rates for all or some drug types. Few studies examined changes in error severity, but minor errors were most often reported as decreasing. Several studies reported increases in the rate of duplicate orders and failures to discontinue drugs, often attributed to inappropriate selection from a dropdown menu or to an inability to view all active medication orders concurrently. The evidence-base reporting the effectiveness of CPOE to reduce prescribing errors is not compelling and is limited by modest study sample sizes and designs. Future studies should include larger samples including multiple sites, controlled study designs, and standardized error and severity reporting. The role of decision support in minimizing severe prescribing error rates also requires investigation. [References: 63]

Rudin RS, Motala A, Goldzweig CL, Shekelle PG. **Usage and effect of health information exchange: a systematic review**. Ann Intern Med 2014;161(11):803-811.
Abstract: BACKGROUND: Health information exchange (HIE) is increasing in the United States, and it is incentivized by government policies.PURPOSE: To systematically review and evaluate evidence of the use and effect of HIE on clinical care.
DATA SOURCES: Selected databases from 1 January 2003 to 31 May 2014.
STUDY SELECTION: English-language hypothesis-testing or quantitative studies of several types of data exchange among unaffiliated organizations for use in clinical care that addressed health outcomes, efficiency, utilization, costs, satisfaction, HIE usage, sustainability, and attitudes or barriers.
DATA EXTRACTION: Data extraction was done in duplicate.
DATA SYNTHESIS: Low-quality evidence from 12 hypothesis-testing studies supports an effect of HIE use on reduced use or costs in the emergency department. Direct evidence that HIEs were used by providers was reported in 21 studies involving 13 distinct HIE organizations, 6 of which were located in New York, and generally showed usage in less than 10% of patient encounters. Findings from 17 studies of sustainability suggest that approximately one quarter of existing HIE organizations consider themselves financially stable. Findings from 38 studies about attitudes and barriers showed that providers, patients, and other stakeholders consider HIE to be valuable, but barriers include technical and workflow issues, costs, and privacy concerns.
LIMITATION: Publication bias, possible selective reporting of outcomes, and a dearth of reporting on context and implementation processes.
CONCLUSION: Health information exchange use probably reduces emergency department usage and costs in some cases. Effects on other outcomes are unknown. All stakeholders claim to value HIE, but many barriers to acceptance and sustainability exist. A small portion of operational HIEs have been evaluated, and more research is needed to identify and understand success factors.
PRIMARY FUNDING SOURCE: U.S. Department of Veterans Affairs. (PROSPERO registration number: CRD42014007469).

Shachak A, Reis S. **The impact of electronic medical records on patient-doctor communication during consultation: a narrative literature review**. J Eval Clin Pract 2009;15(4):641-649.
Abstract: RATIONALE, AIMS AND OBJECTIVE: The effect of Electronic Medical Record (EMR) use on Patient-Doctor Communication (PDC) has rarely been studied. As data accumulate, the purpose of this article is to review the literature on EMR effect on PDC, to

identify recurring themes and to offer preliminary guidelines and future directions for medical education and research.
METHOD: A database search was conducted and 14 articles that met inclusion criteria (published in the past 10 years, empirical investigations, direct assessment of the EMR impact on patient-doctor communication) were selected for review. A qualitative, grounded theory-like approach was employed to analyse the data.
RESULTS: EMR use often has a positive impact on information exchange, but exerts a negative influence on patient centredness. Some physician characteristics such as their computer skills and behavioural style assist in overcoming this negative influence.
CONCLUSION: The use of EMR exerts both positive and negative impacts on physician-patient relationships. The negative impacts can be overcome by some simple means as well as better designs of EMR systems and medical education interventions. Physicians' everyday practices of integrating EMR use into the clinical encounter as well as better design of EMR systems and EMR and communication training may facilitate PDC in computerized settings. [References: 63]

Shamliyan TA, Duval S, Du J, Kane RL. **Just what the doctor ordered. Review of the evidence of the impact of computerized physician order entry system on medication errors**. Health Serv Res 2008;43(1 Pt 1):32-53.
Abstract: OBJECTIVE: To examine the association between computerization of physician orders and prescribing medication errors. Data Sources. Studies published in English language were identified through MEDLINE (1990 through December 2005), Cochrane Central Register of Controlled Trials, and bibliographies of retrieved articles. Of 252 identified in the search, 12 (4.8 percent) original investigations that compared rates of prescribing medication errors with handwritten and computerized physician orders were included.
DATA COLLECTION: Information on study design, participant characteristics, clinical settings, and outcomes rates were abstracted independently by two investigators using a standardized protocol.
PRINCIPAL FINDINGS: Compared with handwritten orders, 80 percent of studies (8/10 studies) reported a significant reduction in total prescribing errors, 43 percent in dosing errors (3/7 studies), and 37.5 percent in adverse drug events (3/8 studies). The use of computerized orders was associated with a 66 percent reduction in total prescribing errors in adults (odds ratio [OR]=0.34; 95 percent confidence interval [CI] 0.22-0.52) and a positive tendency in children (p for interaction=.028). The benefit of computerized orders was larger when the rate of errors was more than 12 percent with handwritten orders (p for interaction=.022). Significant heterogeneity in the results compromised pooled relative risks. One randomized controlled intervention demonstrated the greatest benefits of computerized orders on total prescribing errors (OR=0.02, 95 percent CI 0.01-0.02) and dosing errors (OR=0.28; 95 percent CI 0.15-0.52) with 775 avoided prescribing errors (95 percent CI 752-811) per 1,000 orders in a pediatric hospital.
CONCLUSIONS: Computerization of physicians' orders shows great promise. It will be more effective when linked to other computerized systems to detect and prevent prescribing errors. [References: 72]

Stuerzlinger H, Hiebinger C, Pertl D, Traurig P. **Computerized physician order entry - effectiveness and efficiency of electronic medication ordering with decision support systems (Structured abstract)**. Health Technology Assessment Database German Agency for Health Technology Assessment at the German Institute for Medical Documentation and Information (DAHTA DIMDI); 2009.

Thomas SK, Coleman JJ. **The impact of computerised physician order entry with integrated clinical decision support on pharmacist-physician communication in the hospital setting: a systematic review of the literature (Provisional abstract)**. European

Journal of Hospital Pharmacy2012. p. 349-354.

Urquhart C, Currell R, Grant Maria J, Hardiker Nicholas R. **Nursing record systems: effects on nursing practice and healthcare outcomes**. Cochrane Database of Systematic Reviews John Wiley & Sons, Ltd; 2009.

Abstract: Background: A nursing record system is the record of care that was planned or given to individual patients and clients by qualified nurses or other caregivers under the direction of a qualified nurse. Nursing record systems may be an effective way of influencing nurse practice. Objectives: To assess the effects of nursing record systems on nursing practice and patient outcomes. Search methods: For the original version of this review in 2000, and updates in 2003 and 2008, we searched: the Cochrane Effective Practice and Organisation of Care (EPOC) Group Specialised Register; MEDLINE, EMBASE, CINAHL, BNI, ISI Web of Knowledge, and ASLIB Index of Theses. We also handsearched: Computers, Informatics, Nursing (Computers in Nursing); Information Technology in Nursing; and the Journal of Nursing Administration. For this update, searches can be considered complete until the end of 2007. We checked reference lists of retrieved articles and other related reviews. Selection criteria: Randomised controlled trials (RCTs), controlled before and after studies, and interrupted time series comparing one kind of nursing record system with another in hospital, community or primary care settings. The participants were qualified nurses, students or healthcare assistants working under the direction of a qualified nurse, and patients receiving care recorded or planned using nursing record systems. Data collection and analysis: Two review authors (in two pairs) independently assessed trial quality and extracted data. Main results: We included nine trials (eight RCTs, one controlled before and after study) involving 1846 people. The studies that evaluated nursing record systems focusing on relatively discrete and focused problems, for example effective pain management in children, empowering pregnant women and parents, reducing loss of notes, reducing time spent on data entry of test results, reducing transcription errors, and reducing the number of pieces of paper in a record, all demonstrated some degree of success in achieving the desired results. Studies of nursing care planning systems and total nurse records demonstrated uncertain or equivocal results. Authors' conclusions: We found some limited evidence of effects on practice attributable to changes in record systems. It is clear from the literature that it is possible to set up the randomised trials or other quasi-experimental designs needed to produce evidence for practice. Qualitative nursing research to explore the relationship between practice and information use could be used as a precursor to the design and testing of nursing information systems.

van Rosse F, Maat B, Rademaker CM, van Vught AJ, Egberts AC, Bollen CW. **The effect of computerized physician order entry on medication prescription errors and clinical outcome in pediatric and intensive care: a systematic review**. Pediatrics 2009;123(4):1184-1190.

Abstract: CONTEXT: Pediatric and intensive care patients are particularly at risk for medication errors. Computerized physician order entry systems could be effective in reducing medication errors and improving outcome. Effectiveness of computerized physician order entry systems has been shown in adult medical care. However, in critically ill patients and/or children, medication prescribing is a more complex process, and usefulness of computerized physician order entry systems has yet to be established.

OBJECTIVE: To evaluate the effects of computerized physician order entry systems on medication prescription errors, adverse drug events, and mortality in inpatient pediatric care and neonatal, pediatric or adult intensive care settings.

METHODS: PubMed, the Cochrane library, and Embase up to November 2007 were used as our data sources. Inclusion criteria were studies of (1) children 0 to 18 years old and/or ICU patients (including adults), (2) computerized physician order entry versus no computerized physician order entry as intervention, and (3) randomized trial or observational

study design. All studies were validated, and data were analyzed. RESULTS. Twelve studies, all observational, met our inclusion criteria. Eight studies took place at an ICU: 4 were adult ICUs, and 4 were PICUs and/or NICUs. Four studies were pediatric inpatient studies. Meta-analysis showed a significant decreased risk of medication prescription errors with use of computerized physician order entry. However, there was no significant reduction in adverse drug events or mortality rates. A qualitative assessment of studies revealed the implementation process of computerized physician order entry software as a critical factor for outcome.
CONCLUSIONS: Introduction of computerized physician order entry systems clearly reduces medication prescription errors; however, clinical benefit of computerized physician order entry systems in pediatric or ICU settings has not yet been demonstrated. The quality of the implementation process could be a decisive factor determining overall success or failure. [References: 30]

Walsh C, Siegler EL, Cheston E, O'Donnell H, Collins S, Stein D, et al. **Provider-to-provider electronic communication in the era of meaningful use: A review of the evidence**. J Hosp Med 2013;8(10):589-597.
Abstract: BACKGROUND: Electronic communication between providers occurs daily in clinical practice but has not been well studied. PURPOSE: To assess the impact of provider-to-provider electronic communication tools on communication and healthcare outcomes through literature review. DATA SOURCES: Ovid MEDLINE, PubMed, Google Scholar, Cumulative Index to Nursing and Allied Health Literature, and Academic Search Premier. STUDY SELECTION: Publication in English-language peer-reviewed journals. Studies provided quantitative provider-to-provider communication data, provider satisfaction statistics, or electronic health record (EHR) communication data. DATA EXTRACTION: Literature review. DATA SYNTHESIS: Two reviewers conducted the title review to determine eligible studies from initial search results. Three reviewers independently reviewed titles, abstracts, and full text (where appropriate) against inclusion and exclusion criteria. LIMITATIONS: Small number of eligible studies; few described trial design (20%). Homogeneous provider type (physicians). English-only studies. CONCLUSIONS: Of 25 included studies, all focused on physicians; most were observational (68%). Most (60%) described electronic specialist referral tools. Although overall use has been measured, there were no studies of the effectiveness of intra-EHR messaging. Literature describing the effectiveness of provider-to-provider electronic communications is sparse and narrow in scope. Complex care, such as that envisioned for the Patient Centered Medical Home, necessitates further research. © 2013 Society of Hospital Medicine.

Wolfstadt JI, Gurwitz JH, Field TS, Lee M, Kalkar S, Wu W, et al. **The effect of computerized physician order entry with clinical decision support on the rates of adverse drug events: a systematic review**. J Gen Intern Med 2008;23(4):451-458.
Abstract: CONTEXT: Computerized physician order entry (CPOE) with clinical decision support (CDS) has been promoted as an effective strategy to prevent the development of a drug injury defined as an adverse drug event (ADE).
OBJECTIVE: To systematically review studies evaluating the effects of CPOE with CDS on the development of an ADE as an outcome measure.
DATA SOURCES: PUBMED versions of MEDLINE (from inception through March 2007) were searched to identify relevant studies. Reference lists of included studies were also searched.
METHODS: We searched for original investigations, randomized and nonrandomized clinical trials, and observational studies that evaluated the effect of CPOE with CDS on the rates of ADEs. The studies identified were assessed to determine the type of computer system used, drug categories being evaluated, types of ADEs measured, and clinical outcomes assessed.

RESULTS: Of the 543 citations identified, 10 studies met our inclusion criteria. These studies were grouped into categories based on their setting: hospital or ambulatory; no studies related to the long-term care setting were identified. CPOE with CDS contributed to a statistically significant (P < or = .05) decrease in ADEs in 5 (50.0%) of the 10 studies. Four studies (40.0%) reported a nonstatistically significant reduction in ADE rates, and 1 study (10.0%) demonstrated no change in ADE rates.
CONCLUSIONS: Few studies have measured the effect of CPOE with CDS on the rates of ADEs, and none were randomized controlled trials. Further research is needed to evaluate the efficacy of CPOE with CDS across the various clinical settings. [References: 39]

Wollersheim D, Sari A, Rahayu W. **Archetype-based electronic health records: a literature review and evaluation of their applicability to health data interoperability and access**. The HIM journal 2009;38(2):7-17.
Abstract: Health Information Managers (HIMs) are responsible for overseeing health information. The change management necessary during the transition to electronic health records (EHR) is substantial, and ongoing. Archetype-based EHRs are a core health information system component which solve many of the problems that arise during this period of change. Archetypes are models of clinical content, and they have many beneficial properties. They are interoperable, both between settings and through time. They are more amenable to change than conventional paradigms, and their design is congruent with clinical practice. This paper is an overview of the current archetype literature relevant to Health Information Managers. The literature was sourced in the English language sections of ScienceDirect, IEEE Explore, Pubmed, Google Scholar, ACM Digital library and other databases on the usage of archetypes for electronic health record storage, looking at the current areas of archetype research, appropriate usage, and future research. We also used reference lists from the cited papers, papers referenced by the openEHR website, and the recommendations from experts in the area. Criteria for inclusion were (a) if studies covered archetype research and (b) were either studies of archetype use, archetype system design, or archetype effectiveness. The 47 papers included show a wide and increasing worldwide archetype usage, in a variety of medical domains. Most of the papers noted that archetypes are an appropriate solution for future-proof and interoperable medical data storage. We conclude that archetypes are a suitable solution for the complex problem of electronic health record storage and interoperability.

Vedlegg 1

Søkestrategier

Database: Cochrane Central Register of Controlled Trials (CENTRAL)
Dato for søk: 16. april 2015

#1	MeSH descriptor: [Health Information Systems] explode all trees
#2	MeSH descriptor: [Health Information Exchange] explode all trees
#3	MeSH descriptor: [Medical Order Entry Systems] explode all trees
#4	(((data or information or record* or journal* or document*) near/3 (patient* or health or medical?)) or (discharge next (note* or plan*)) or epicris* or referral*)
#5	MeSH descriptor: [Medical Records Systems, Computerized] this term only
#6	#4 or #5
#7	(share or shares or shared or sharing)
#8	((between or across or among) near/3 (setting* or provider* or clinic* or department* or site* or insititution* or organisation* or organization* or disciplin* or profession*))
#9	exchang*
#10	seamless
#11	#7 or #8 or #9 or #10
#12	#6 and #11
#13	HIE
#14	#1 or #2 or #3 or #12 or #13 Publication Year from 2008 to 2015, in Trials

Database: DARE, HTA via Cochrane Library
Dato for søk: 16. april 2015

#1	MeSH descriptor: [Health Information Systems] explode all trees
#2	MeSH descriptor: [Health Information Exchange] explode all trees
#3	MeSH descriptor: [Medical Order Entry Systems] explode all trees
#4	(((data or information or record* or journal* or document*) near/3 (patient* or health or medical?)) or (discharge next (note* or plan*)) or epicris* or referral*):ti,ab,kw
#5	MeSH descriptor: [Medical Records Systems, Computerized] this term only
#6	#4 or #5
#7	(share or shares or shared or sharing):ti,ab,kw

#8	**((between or across or among) near/3 (setting* or provider* or clinic* or department* or site* or insititution* or organisation* or organization* or disciplin* or profession*)):ti,ab,kw**
#9	**exchang*:ti,ab,kw**
#10	**seamless:ti,ab,kw**
#11	**#7 or #8 or #9 or #10**
#12	**#6 and #11**
#13	**HIE:ti,ab,kw**
#14	**#1 or #2 or #3 or #12 or #13 Publication Year from 2008 to 2015, in Cochrane Reviews (Reviews and Protocols), Other Reviews and Technology Assessments**

Database: DARE, HTA via Centre for Reviews and Dissemination
Dato for søk: 16.april 2015
Antall treff: 262

Line	Search	Hits	
	1	MeSH DESCRIPTOR Health Information Systems EXPLODE ALL TREES	3
	2	MeSH DESCRIPTOR Health Information Exchange EXPLODE ALL TREES	0
	3	MeSH DESCRIPTOR Medical Order Entry Systems EXPLODE ALL TREES	28
	4	MeSH DESCRIPTOR Medical Records Systems, Computerized EXPLODE ALL TREES	102
	5	((((data or information or record* or journal* or document*) adj3 (patient* or health or medical?)) or (discharge adj (note* or plan*)) or epicris* or referral*))	20448
	6	#4 OR #5	20487
	7	((share or shares or shared or sharing))	508
	8	(((between or across or among) adj3 (setting* or provider* or clinic* or department* or site* or insititution* or organisation* or organization* or disciplin* or profession*)))	800
	9	(exchang*)	778
	10	(seamless)	3
	11	#7 OR #8 OR #9 OR #10	2004
	12	#6 AND #11	721
	13	(HIE)	14

☐	14	#1 OR #2 OR #3 OR #12 OR #13	761
☐	15	* IN DARE, HTA FROM 2008 TO 2015	41157
☐	16	#14 AND #15	262

Database: Embase 1974 to 2015 June 26
Dato for søk: 16.april 2015
Antall treff: 5263

#	Searches	Results
1	health information systems.ti,ab.	1196
2	HIE.ti,ab.	2049
3	(((data or information or record* or journal* or document*) adj3 (patient* or health or medical?)) or (discharge adj (note* or plan*)) or epicris* or referral*).ti,ab.	566508
4	((between or across or among) adj3 (setting* or provider* or clinic* or department* or site* or insititution* or organisation* or organization* or disciplin* or profes-sion*)).ti,ab.	177621
5	3 and 4	17150
6	1 or 2 or 5 [HIE]	20279
7	(((systematic* or literature) adj2 (overview or review* or search*)) or meta-analys*).ti,ab.	293212
8	"systematic review"/	91314
9	meta analysis/	95270
10	or/7-9 [SR]	337391
11	6 and 10	659
12	limit 11 to yr="2008 -Current" [HIE +SR]	483
13	clinical trial/	850743
14	randomized controlled trial/	377751
15	exp randomization/	66930
16	randomized.ti,ab.	468883
17	randomised.ti,ab.	93574
18	randomly.ti,ab.	296205
19	trial.ti,ab.	533229
20	controlled study/	4642323
21	time series analysis/	15534
22	pretest posttest design/	831
23	evaluation/	170244
24	intervention study/	24443
25	comparative study/	679849
26	experimental study/	16535
27	time series.ti,ab.	20671
28	(((pre adj test) or pretest) and ((post adj test) or posttest)).ti,ab.	8974
29	time point*.ti,ab.	105966
30	repeated measur*.ti,ab.	39613

31	effect.ti,ab.	2954256
32	impact.ti,ab.	774068
33	or/13-32 [RCT,CBA,ITS]	8506586
34	6 and 33	7884
35	limit 34 to yr="2008 -Current" [RCT,CBA,ITS + HIE]	4991
36	12 or 35	5263

Database: Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily, Ovid MEDLINE(R) and Ovid OLDMEDLINE(R) 1946 to Present
Dato for søk: 16. April 2015
Antall treff: 3343

#	Searches	Results
1	Health Information Systems/	441
2	Health Information Exchange/	110
3	medical order entry systems/	1669
4	Medical Records Systems, Computerized/	18391
5	(((data or information or record* or journal* or document*) adj3 (patient* or health or medical?)) or (discharge adj (note* or plan*)) or epicris* or referral*).ti,ab.	379876
6	4 or 5	389533
7	(share or shares or shared or sharing).ti,ab.	219161
8	((between or across or among) adj3 (setting* or provider* or clinic* or department* or site* or insititution* or organisation* or organization* or disciplin* or profes-sion*)).ti,ab.	132807
9	exchang*.ti,ab.	218853
10	seamless.ti,ab.	2178
11	or/7-10	561317
12	6 and 11	20756
13	HIE.ti,ab.	1258
14	health information exchange.kw.	76
15	1 or 2 or 3 or 12 or 13 or 14	23831
16	(((systematic* or literature) adj2 (overview or review* or search*)) or meta-analys*).ti,ab.	234576
17	systematic review.kw.	2339
18	16 or 17	234681
19	15 and 18	815
20	limit 19 to yr="2008 -Current"	612
21	randomized controlled trial.pt.	398691
22	controlled clinical trial.pt.	89791
23	randomi?ed.ti,ab.	415200
24	randomly.ti,ab.	234158
25	trial.ti,ab.	397972
26	evaluation studies.pt,sh.	205921
27	intervention studies.pt,sh.	7859

28	comparative study.pt,sh.	1714429
29	(comparative adj stud*).tw.	80342
30	experimental stud*.tw.	78849
31	(time adj series).tw.	17900
32	((pre test or pretest) and (post test or posttest)).tw.	7168
33	(time adj point*).tw.	73242
34	(repeated adj measur*).tw.	29880
35	effect.ti.	747184
36	impact.ti.	131870
37	21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36	3527653
38	15 and 37	5036
39	limit 38 to yr="2008 -Current"	2898
40	health information exchange.ti. [high value phrase]	273
42	20 or 39 or 40	3343

Vedlegg 2

Samhandling mellom tjenestenivåer og fagfolk

Randomiserte studier
Munck LK, Hansen KR, Grethe Molbak A, Balle H, Kongsgren S. **The use of shared medication record as part of medication reconciliation at hospital admission is feasible**. Dan Med J2014. Abstract: INTRODUCTION: Medication reconciliation improves congruence in cross sectional patient courses. Our regional electronic medical record (EMR) integrates the shared medication record (SMR) which provides full access to current medication and medication prescriptions for all citizens in Denmark. We studied whether our SMR integration could facilitate medication reconciliation. MATERIAL AND METHODS: Patients admitted to the emergency department for hospitalization were randomised to consultation using EMR with or without the integrated SMR access. Observed time used for medication reconciliation was the primary efficacy parameter. RESULTS: A total of 62 consecutive patient consultations were randomised including 39 with more than five prescriptions. EMR had data from previous consultations for 46 patients, 59 patients provided information on medication. In all, 18 junior physicians in early postgraduate medical training each participated with a median of three consultations (range 1-9). Time expenditure for medicine reconciliation was 5:27 min.:sec. (range: 2:00-15:37) with access to SMR integration and 4:15 min.:sec. (1:15-12:00) without SMR access. The number of active medicine prescriptions was eight and nine, respectively. Incorporating SMR did not increase the work load. Physicians judged the SMR integration and workflow as being useful. Patients unambiguously supported physicians' use of SMR in this setting. CONCLUSION: Integration of information on individuals' medication from a national SMR into a hospital EMR was feasible and useful, and it did not increase time expenditure for medication reconciliation.
Okoniewska BM, Santana MJ, Holroyd-Leduc J, Flemons W, O'Beirne M, White D, et al. **The Seamless Transfer-of-Care Protocol: a randomized controlled trial assessing the efficacy of an electronic transfer-of-care communication tool**. BMC Health Serv Res2012. p. 414. Abstract: BACKGROUND: The transition between acute care and community care represents a vulnerable period in health care delivery. The vulnerability of this period has been attributed to changes to patients' medication regimens during hospitalization, failure to reconcile discrepancies between admission and discharge and the burdening of pa-

tients/families to take over care responsibilities at discharge and to relay important information to the primary care physician. Electronic communication platforms can provide an immediate link between acute care and community care physicians (and other community providers), designed to ensure consistent information transfer. This study examines whether a transfer-of-care (TOC) communication tool is efficacious and cost-effective for reducing hospital readmission, adverse events and adverse drug events as well as reducing death. METHODS: A randomized controlled trial conducted on the Medical Teaching Unit of a Canadian tertiary care centre will evaluate the efficacy and cost-effectiveness of a TOC communication tool. Medical in-patients admitted to the unit will be considered for this study. Data will be collected upon admission, and a total of 1400 patients will be randomized. The control group's acute care stay will be summarized using a traditional dictated summary, while the intervention group will have a summary generated using the TOC communication tool. The primary outcome will be a composite, at 3 months, of death or readmission to any Alberta acute-care hospital. Secondary outcomes will be the occurrence of post-discharge adverse events and adverse drug events at 1 month post discharge. Patients with adverse outcomes will have their cases reviewed by two Royal College certified internists or College-certified family physicians, blinded to patients' group assignments, to determine the type, severity, preventability and ameliorability of all detected adverse outcomes. An accompanying economic evaluation will assess the cost per life saved, cost per readmission avoided and cost per QALY gained with the TOC communication tool compared to traditional dictation summaries. DISCUSSION: This paper outlines the study protocol for a randomized controlled trial evaluating an electronic transfer-of-care communication tool, with sufficient statistical power to assess the impact of the tool on the significant outcomes of post-discharge death or readmission. The study findings will inform health systems around the world on the potential benefits of such tools, and the value for money associated with their widespread implementation. TRIAL REGISTRATION: ClinicalTrials.gov NCT01402609.

Player MS, Gill JM, Mainous AG, Everett CJ, Koopman RJ, Diamond JJ, et al. **An electronic medical record-based intervention to improve quality of care for gastro-esophageal reflux disease (GERD) and atypical presentations of GERD**. Qual Prim Care2010. p. 223-229.

Abstract: BACKGROUND: Gastro-esophageal reflux disease (GERD) is common in primary care but is often underdiagnosed and untreated. GERD can also present with atypical symptoms like chronic cough and asthma, and physicians may be unaware of this presentation. We aimed to implement and evaluate an intervention to improve diagnosis and treatment for GERD and atypical GERD in primary care. METHOD: This was a randomised controlled trial in primary care office practice using a national network of US practices (the Medical Quality Improvement Consortium - MQIC) that share the same electronic medical record (EMR). Thirteen offices with 53 providers were randomised to the intervention of EMR-based prompts and education, and 14 offices with 66 providers were randomised to the control group totalling over 67 000 patients and examining outcomes of GERD diagnosis and appropriate treatment. RESULTS: Among patients who did not have GERD at baseline, new diagnoses of GERD increased significantly in the intervention group (3.1%) versus the control group (2.3%) ($P<0.01$). This remained significant after controlling for clustering with an odds of diagnosis of 1.33 (95% CI 1.13-1.56) for the intervention group. For patients with atypical symptoms, those in the intervention group had both higher odds of being diagnosed with GERD (OR 2.02, 95% CI 1.41-2.88) and of being treated for GERD (OR 1.40, 95% CI 1.08-1.83) than those in the control group. CONCLUSIONS: GERD diagnosis and treatment in primary care, particularly among patients with atypical symptoms, can be improved through the use of an EMR-based tool incorporating decision support and education. However, significant room for improvement exists in use of appropriate treatment.

Proeschold-Bell RJ, Belden CM, Parnell H, Cohen S, Cromwell M, Lombard F. **A randomized controlled trial of health information exchange between human immunodeficiency virus institutions**. J Public Health Manag Pract2010. p. 521-528.
Abstract: CONTEXT: In order for patients to benefit from a multidisciplinary treatment approach, diverse providers must communicate on patient care. OBJECTIVE: We sought to examine the effect of information exchange across multidisciplinary human immunodeficiency virus (HIV) care providers on patient health outcomes. DESIGN: Randomized controlled trial, randomized at the patient level. SETTING: Six infectious disease clinics paired with 9 ancillary care settings (eg, HIV case management). PARTICIPANTS: Two hundred fifty-four patients with HIV receiving care at the infectious disease clinics. INTERVENTION: Health information was exchanged for 2 years per patient between medical and ancillary care providers using electronic health records and printouts inserted into charts. Medical care providers gave ancillary care providers HIV viral loads, CD4 values, current medications, and appointment attendance. Ancillary care providers gave medical providers the information on medication adherence and major changes (eg, loss of housing). MAIN OUTCOME MEASURES: We abstracted from medical records HIV viral loads, CD4 counts, and antiretroviral medication prescriptions before and during the intervention. From 0-, 12-, and 24-month patient surveys, we assessed hospitalizations, emergency department use, and health-related quality of life measured by the Medical Outcomes Study Short Form-36 (SF-36). RESULTS: No statistically significant differences between cases and controls were found across time for the following: proportion with suppressed viral load, changes in viral load or CD4 values, patients being prescribed antiretroviral medication, hospitalizations, emergency department visits, or any scale of the SF-36. Trends were mixed but leaned toward better health for control participants. CONCLUSIONS: The exchange of this specific set of information between HIV medical and ancillary care providers was neutral on a variety of patient health outcomes.

Singh K, Ali MK, Devarajan R, Shivashankar R, Pandey S, Ajay VS, et al. **The utility and acceptability of decision support electronic health records (DS-EHR) in diabetes care: The carrs translation trial**. Diabetes 2014;63:A300.
Abstract: In a randomized controlled implementation trial of a clinic based diabetes care improvement model that uses non-physician care coordinators and DSEHR, we evaluated acceptability of the DS-EHR among physicians. In the trial, DS-EHR provides guideline based treatment prompts for physicians caring for 1146 patients at 10 sites, based on the recent glycaemic, BP (blood pressure) and LDLc values. DS-EHR prompts can be accepted or rejected at physician discretion by providing a reason. Over a one year period (Jun 2011-12), 787 DS-EHR management plans were reviewed and 20 key informant (trial physicians) interviews were analyzed. Physician acceptance rates (agreement with DS-EHR plan) for glycaemic, BP and LDLc prompts were 52%, 77%, & 60% respectively. In only 7% of instances all three risk factors prompts were rejected. Physician acceptance rate varied across trial sites: 41-93% for glycaemic prompts and 53-98% for lipids and BP prompts. Commonly cited reasons for rejecting prompts, in order of increasing frequency, were a) Medication non-compliance b) Lack of recent lab values [HbA1c + LDLc] c) Preference for reinforcing lifestyle modifications d) Recent trend of improving lab values e) Switching medications instead of up-titration f) Patients reluctance to take insulin g) Reliance on home glucose and BP records. Interviews with physicians suggested that a) DS-EHR aids focus on risk factor targets b) Glycaemic variability patterns are more clearly visible and help doctors to think through the patient level problems in achieving the targets and making changes in treatment doses c) DS-EHR serves as an acceptable substitute than using junior doctors to screen for uncontrolled risk factors among patients d) Almost all physicians expressed interest in continuing to use the DS-EHR beyond the trial duration. In con-

clusion: Providing actionable patient data and prompts directly to physicians may be helpful to physicians in managing cardiovascular risk factors.

Ikke-randomiserte studier og observasjonelle design

Information exchange yields better decisions. ED management : the monthly update on emergency department management 2010;22(9):103-104.
Abstract: A new study from the Medical College of Wisconsin shows that the Wisconsin Health Information Exchange has not only saved time for the EDs participating, but has helped them make better-informed patient care decisions. EDs in the Milwaukee area are linked to the system with a dedicated computer housed in a separate area of the department. Once registration enters the patient's name into the system, basic information appears about the previous ED visits at all facilities in the city. ED staff can also obtain additional patient information if the need arises.

EMR use in the ED: scant data connect EMRs with positive outcomes, but experts advise managers, providers to consider long-term benefits. ED management : the monthly update on emergency department management 2012;24(3):25-28.
Abstract: A Minnesota study looking into the impact of EMRs on the care of heart failure patients presenting to the ED found mixed results, with two of the sites studied showing small but statistically significant positive benefits, and one site showing little difference between the outcomes of patients who had EMR data vs. patients who presented for care with no EMR data. However, experts predict EMR functionality and usability will gradually improve, and they advise providers to take steps to ensure that EMRs don't interfere with patient-provider communications. In the study looking at the care of HF patients in the ED, data from two of the sites showed that patients with EMRs were less likely to die if hospitalized, they underwent fewer laboratory tests, and they were prescribed fewer medicines during their ED visit than HF patients without EMRs. In a third study site, patients with EMRs were associated with longer LOS in the ED. Experts acknowledge that when used inappropriately, EMRs can be distracting, and they can inhibit patient-provider communications. They advise ED providers and managers to take steps to ensure that EMRs enhance rather than diminish human interactions. The need for EDs to have effective health information exchange is underscored by a new Indiana study showing that people tend to seek emergency care at multiple sites over time.

Health information exchange reduces use of repeated diagnostic imaging for back pain. J Pain Palliat Care Pharmacother 2014;28(2):185-186.
Abstract:

Adams RJ, Debenham E, Chalela J, Chimowitz M, Hays A, Holmstedt C, et al. **Will "real time" access to electronic medical records improve telemedicine stroke consults?** Stroke 2012;43 (2 Meeting Abstracts).
Abstract: Objectives: The Neuroscience stroke telemedicine program of the Medical University of South Carolina (REACH MUSC) is a robust network of 15 sites served by an academic hub in Charleston. South Carolina's Health Information Exchange (SCHIEx) collects and displays data from all hospital discharges and emergency room visits. At present, our REACH MUSC stroke consults, like most, are not connected to a central electronic medical record or Health Information Exchange (HIE) like SCHIEx. We used our first 250 REACH MUSC consults to estimate the value to a stroke telemedicine consult of a hypothetical "real time" connection to an HIE Methods: After IRB approval, names and identifying information of the first 250 consecutive REACH MUSC stroke consults were provided to the SC Office of Research and Statistics for analysis, along with 10 prespecified questions of inter-

est based on their presumed value in the stroke setting (e.g. "can a history of atrial fibrillation be found?"). A retrospective search of 10 years from the date of the consult was performed using data available also available via SCHIEx. The REACH MUSC consult itself was examined using the same template and the two compared to see if relevant information would have been found in SCHIEx that was not obtained during the actual REACH MUSC consult Results: 249 unique patients were represented in the 250 REACH MUSC consults and, of these, 234 could be located in SCHIEx (others were probably tourists). Much information found on the 234 in SCHIEx was in the form of comorbidities and would not have been of crucial value to the REACH MUSC stroke consult. However, 4 patients in SCHIEx had a history of intra-cerebral hemorrhage and only one of these was noted in the REACH MUSC consult. 24 patients in SCHIEx had a history of "atrial fibrillation" but this history was recorded in only half of the REACH MUSC consults. SCHIEx does not yet have medication data so information on warfarin use was not available Conclusion: This study suggests that real time linkage to an HIE or other sources of historical medical data might indeed improve the quality of stroke telemedicine consultations, at least from a safety perspective.

Adler-Milstein J, Salzberg C, Franz C, Orav EJ, Newhouse JP, Bates DW. **Effect of electronic health records on health care costs: Longitudinal comparative evidence from community practices**. Ann Intern Med 2013;159(2):97-104.
Abstract: Background: The United States is aiming to achieve nationwide adoption of electronic health records (EHRs) but lacks robust empirical evidence to anticipate the effect on health care costs. Objective: To assess short-term cost savings from community-wide adoption of ambulatory EHRs. Design: Longitudinal trial with parallel control group. Setting: Natural experiment in which 806 ambulatory clinicians across 3 Massachusetts communities adopted subsidized EHRs. Six matched control communities applied but were not selected to participate. Patients: 47 979 intervention patients and 130 603 control patients. Measurements: Monthly standardized health care costs from commercial claims data from January 2005 to June 2009, including total cost, inpatient cost, and ambulatory cost and its subtypes (pharmacy, laboratory, and radiology). Projected savings per member per month (PMPM), excluding EHR adoption costs. Results: Ambulatory EHR adoption did not impact total cost (preto postimplementation difference in monthly trend change, -0.30 percentage point; P - 0.135), but the results favored savings (95% CI, $21.95 PMPM in savings to $1.53 PMPM in higher costs). It slowed ambulatory cost growth (difference in monthly trend change, 0.35 percentage point; P =0.012); projected ambulatory savings were $4.69 PMPM (CI, $8.45 to $1.09 PMPM) (3.10% of total PMPM cost). Ambulatory radiology costs decreased (difference in monthly trend change, -1.61 percentage points; P = 0.001), with projected savings of $1.61 PMPM (1.07% of total PMPM cost). Limitations: Intervention communities were not randomly selected and received implementation support, suggesting that results may represent a best-case scenario. Confounding is possible. Conclusion: Using commercially available EHRs in community practices seems to modestly slow ambulatory cost growth. Broader changes in the organization and payment of care may prompt clinicians to use EHRs in ways that result in more substantial savings. © 2013 American College of Physicians.

Ahmed J, Mehmood S, Rehman S, Ilyas C, Khan LUR. **Impact of a structured template and staff training on compliance and quality of clinical handover**. International Journal of Surgery 2012;10(9):571-574.
Abstract: Introduction: Change in junior doctors working pattern has brought effective and safe clinical handover into a central role to ensure the patient safety and high quality care. We investigated whether the compliance and quality of clinical handover could be improved through the use of a standardised and structured handover template. Methods: A computerised template was developed in accordance with handover guidelines provided

by the Royal College of Surgeons of England. Pre- and post-intervention audits against an eleven-point dataset pertaining to the handover of acute surgical admissions were undertaken. The results from the two discrete audits periods were compared to examine the impact of intervention. Results: There were 137 acute surgical admissions during pre-intervention and 155 admissions in post-intervention audit period. A significant improvement in overall handover practice was observed in post-intervention period. The documentation of patient hospital number (84 (61%) vs. 132 (85%) $p < 0.001$), past medical history (39 (28%) vs. 75 (48%) $p < 0.001$) and patient assessment by a senior member of the on-call team (3 (2%) vs. 125 (85%) $p < 0.001$) all demonstrated significant improvements upon use of structured template. Compliance to effective handover improved following increased awareness of the importance of safe clinical handover among the junior doctors. Conclusion: Implementation of a standardised guideline-based structured handover template and training of junior doctors are likely to improve compliance to agreed standards, promote quality of care, and protect patient safety. © 2012 Surgical Associates Ltd.

Amusan AA, Tongen S, Speedie SM, Mellin A. **A time-motion study to evaluate the impact of EMR and CPOE implementation on physician efficiency**. J Healthc Inf Manag 2008;22(4):31-37.
Abstract: The objective of this research is to determine the impact of EMR and CPOE implementation on physician efficiency. A time series observational study was conducted within a hospital setting at six weeks pre-implementation, six weeks post-implementation and five months post-implementation. All 19 subjects were observed twice with one patient per observation. Physician follow-up rounding times per patient were measured. Physicians demonstrated a mean total rounding time of 18.79 minutes (pre-implementation); 16.97 minutes (six weeks post-implementation); and 12.97 minutes (five months post). Overall, the results showed a statistically significant F value = 8.26 > 1 ($p = 0.0011$) that signifies a reduction in physician rounding time within the hospital setting following EMR implementation. Results also showed overall standard deviations of 6.96 minutes (pre-implementation); 5.13 minutes (six weeks post); and 3.69 minutes (five months post), possibly signifying a reduction in variability and a narrower distribution of rounding times with increased similarity in physicians' rounding patterns.

Angiollilo J, Fleischman W, Kuperman G, Onyile A, Shapiro JS. **Improving identification of hospital readmissions using a regional health information exchange**. Acad Emerg Med 2012;19:S50.
Abstract: Background: Hospital readmissions within 30 days, many of which occur via the ED, are proposed as a target for improvement via "payment incentives" by the Center for Medicare and Medicaid Services. A portion of readmissions, however, occur away from the discharging hospital, making it difficult for hospitals to identify part of this population. Objectives: To demonstrate the extent to which a health information exchange system (HIE) can identify the marginal increase in 30-day readmissions and ED visits of recently discharged patients, which potentially lead to these readmissions. Methods: Data from 5/1/10 to 4/30/11 from the New York Clinical Information Exchange (NYCLIX), a HIE in New York City that includes ten hospitals with a total of 7,717 inpatient beds, were analyzed to calculate hospital index discharges and subsequent readmissions and ED visits to the discharging hospital versus other hospitals. (Table presented) Results: There were 320,967 inpatient admissions/discharges by 271,460 patients. There were 41,630 (13% of total discharges) readmissions within 30 days of discharge, with 37,829 readmissions occurring at the same hospital, while 3,801 patients (9.1% of total readmissions and 1.2% of total discharges) were readmitted to a different hospital. Site-specific increases in identification of readmissions ranged from 3%-25%, SD 8.7 (see table). There were 37,697 ED visits within 30 days of discharge, with 34,143 (91%) visits to the discharging hospital's ED and 3,554 (9%) visits to a different hospital's ED. Conclusion: Readmissions and ED visits

within thirty days of discharge to non-discharging hospitals were common among this group of hospitals and patients during the study period. The use of a HIE helped identify many additional readmissions, though the benefits were lower for hospitals not located in the relative vicinity of another NYCLIX hospital. Measures that take a community, rather than a single institution, into account may be more reflective of the care that the patient experiences.

Bailey JE, Pope RA, Elliott EC, Wan JY, Waters TM, Frisse ME. **Health information exchange reduces repeated diagnostic imaging for back pain**. Ann Emerg Med 2013;62(1):16-24.

Abstract: STUDY OBJECTIVE: This study seeks to determine whether health information exchange reduces repeated diagnostic imaging and related costs in emergency back pain evaluation.

METHODS: This was a longitudinal data analysis of health information exchange patient-visit data. All repeated emergency department (ED) patient visits for back pain with previous ED diagnostic imaging to a Memphis metropolitan area ED between August 1, 2007, and July 31, 2009, were included. Use of a regional health information exchange by ED personnel to access the patient's record during the emergency visit was the primary independent variable. Main outcomes included repeated lumbar or thoracic diagnostic imaging (radiograph, computed tomography [CT], or magnetic resonance imaging [MRI]) and total patient-visit estimated cost.

RESULTS: One hundred seventy-nine (22.4%) of the 800 qualifying repeated back pain visits resulted in repeated diagnostic imaging (radiograph 84.9%, CT 6.1%, and MRI 9.5%). Health information exchange use in the study population was low, at 12.5%, and health care providers as opposed to administrative/nursing staff accounted for 80% of the total health information exchange use. Health information exchange use by any ED personnel was associated with reduced repeated diagnostic imaging (odds ratio 0.36; 95% confidence interval 0.18 to 0.71), as was physician or nurse practitioner health information exchange use (odds ratio 0.47; 95% confidence interval 0.23 to 0.96). No cost savings were associated with health information exchange use because of increased CT imaging when health care providers used health information exchange.

CONCLUSION: Health information exchange use is associated with 64% lower odds of repeated diagnostic imaging in the emergency evaluation of back pain. Health information exchange effect on estimated costs was negligible. More studies are needed to evaluate specific strategies to increase health information exchange use and further decrease potentially unnecessary diagnostic imaging and associated costs of care.

Bailey JE, Wan JY, Mabry LM, Landy SH, Pope RA, Waters TM, et al. **Does health information exchange reduce unnecessary neuroimaging and improve quality of headache care in the emergency department?** J Gen Intern Med 2013;28(2):176-183.

Abstract: BACKGROUND: Health information exchange (HIE) is advocated as an approach to reduce unnecessary testing and improve quality of emergency department (ED) care, but little evidence supports its use. Headache is a specific condition for which HIE has theoretical benefits.

OBJECTIVE: To determine whether health information exchange (HIE) reduces potentially unnecessary neuroimaging, increases adherence with evidence-based guidelines, and decreases costs in the emergency department (ED) evaluation of headache.

DESIGN: Longitudinal data analysis

SUBJECTS: All repeat patient-visits (N=2,102) by all 1,252 adults presenting with headache to a Memphis metropolitan area ED two or more times between August 1, 2007 and July 31, 2009.

INTERVENTION: Use of a regional HIE connecting the 15 major adult hospitals and two regional clinic systems by authorized ED personnel to access the patient's record during the time period in which the patient was being seen in the ED.
MAIN MEASURES: Diagnostic neuroimaging (CT, CT angiography, MRI or MRI angiography), evidence-based guideline adherence, and total patient-visit estimated cost.
KEY RESULTS: HIE data were accessed for 21.8 % of ED patient-visits for headache. 69.8 % received neuroimaging. HIE was associated with decreased odds of diagnostic neuroimaging (odds ratio [OR] 0.38, confidence interval [CI] 0.29-0.50) and increased adherence with evidence-based guidelines (OR 1.33, CI 1.02-1.73). Administrative/nursing staff HIE use (OR 0.24, CI 0.17-0.34) was also associated with decreased neuroimaging after adjustment for confounding factors. Overall HIE use was not associated with significant changes in costs.
CONCLUSIONS: HIE is associated with decreased diagnostic imaging and increased evidence-based guideline adherence in the emergency evaluation of headache, but was not associated with improvements in overall costs. Controlled trials are needed to test whether specific HIE enhancements to increase HIE use can further reduce potentially unnecessary diagnostic imaging and improve adherence with guidelines while decreasing costs of care.

Ben-Assuli O, Shabtai I, Leshno M. **The impact of EHR and HIE on reducing avoidable admissions: controlling main differential diagnoses**. BMC Med Inform Decis Mak 2013;13:49.
Abstract: Many medical organizations have invested heavily in electronic health record (EHR) and health information exchange (HIE) information systems (IS) to improve medical decision-making and increase efficiency. Despite the potential interoperability advantages of such IS, physicians do not always immediately consult electronic health information, and this decision may result in decreased level of quality of care as well as unnecessary costs. This study sought to reveal the effect of EHR IS use on the physicians' admission decisions. It was hypothesizing the using EHR IS will result in more accurate and informed admission decisions, which will manifest through reduction in single-day admissions and in readmissions within seven days. This study used a track log-file analysis of a database containing 281,750 emergency department (ED) referrals in seven main hospitals in Israel. Log-files were generated by the system and provide an objective and unbiased measure of system usage, Thus allowing us to evaluate the contribution of an EHR IS, as well as an HIE network, to decision-makers (physicians). This is done by investigating whether EHR IS lead to improved medical outcomes in the EDs, which are known for their tight time constraints and overcrowding. The impact of EHR IS and HIE network was evaluated by comparing decisions on patients classified by five main differential diagnoses (DDs), made with or without viewing the patients' medical history via the EHR IS. The results indicate a negative relationship between viewing medical history via EHR systems and the number of possibly redundant admissions. Among the DDs, we found information viewed most impactful for gastroenteritis, abdominal pain, and urinary tract infection in reducing readmissions within seven days, and for gastroenteritis, abdominal pain, and chest pain in reducing the single-day admissions' rate. Both indices are key quality measures in the health system. In addition, we found that interoperability (using external information provided online by health suppliers) contributed more to this reduction than local files, which are available only in the specific hospital. Thus, reducing the rate of redundant admissions by using external information produced larger odds ratios (of the beta coefficients; e.g. viewing external information on patients resulted in negative associations of 27.2% regarding readmissions within seven days, and 13% for single-day admissions as compared with viewing local information on patients respectively). Viewing medical history via an EHR IS and using HIE network led to a reduction in the number of seven day readmissions and single-day admissions for all patients. Using external medical history may imply a more thorough patient examination that can help eliminate unnecessary admissions. Nevertheless, in most

instances physicians did not view medical history at all, probably due to the limited resources available, combined with the stress of rapid turnover in ED units.

Boockvar KS, Livote EE, Goldstein N, Nebeker JR, Siu A, Fried T. **Electronic health records and adverse drug events after patient transfer**. Quality & safety in health care 2010;19(5):e16.
Abstract: Our objective was to examine the frequencies of medication error and adverse drug events (ADEs) at the time of patient transfer in a system with an electronic health record (EHR) as compared with a system without an EHR. It was hypothesised that the frequencies of these events would be lower in the EHR system because of better information exchange across sites of care. 469 patients transferred between seven nursing homes and three hospitals in New York and Connecticut between 1999 and 2005 were followed retrospectively. Two groups of patients were compared: US Veterans Affairs (VA) patients, with an EHR, and non-VA patients, without an EHR, on the following measures: (1) medication prescribing discrepancies at nursing home/hospital transfer, (2) high-risk medication discrepancies and (3) ADEs caused by medication discrepancies according to structured medical record review by pairs of physician and pharmacist raters. The overall incidence of ADE caused by medication discrepancies was 0.20 per hospitalisation episode. After controlling for demographic and clinical covariates, there were no significant differences between VA and non-VA groups in medication discrepancies (mean difference 0.02; 95% CI -0.81 to 0.85), high-risk medication discrepancies (-0.18; 95%CI -0.22 to 0.58) or occurrence of an ADE caused by a medication discrepancy (OR 0.96; 95% CI 0.18 to 5.01). There was no difference, with and without an EHR, in the occurrence of medication discrepancies or ADEs caused by medication discrepancies at the time of transfer between sites of care. Reducing such problems may require specialised computer tools to facilitate medication review.

Byrne CM, Mercincavage LM, Bouhaddou O, Bennett JR, Pan EC, Botts NE, et al. **The Department of Veterans Affairs' (VA) implementation of the Virtual Lifetime Electronic Record (VLER): findings and lessons learned from Health Information Exchange at 12 sites**. Int J Med Inform 2014;83(8):537-547.
Abstract: PURPOSE: We describe the Department of Veterans Affairs' (VA) Virtual Lifetime Health Electronic Record (VLER) pilot phase in 12 communities to exchange health information with private sector health care organizations and the Department of Defense (DoD), key findings, lessons, and implications for advancing Health Information Exchanges (HIE), nationally.
METHODS: A mixed methods approach was used to monitor and evaluate the status of VLER Health Exchange pilot phase implementation from December 2009 through October 2012. Selected accomplishments, contributions, challenges, and early lessons that are relevant to the growth of nationwide HIE are discussed.
RESULTS: Veteran patient and provider acceptance, trust, and perceived value of VLER Health Exchange are found to be high, and usage by providers is steadily growing. Challenges and opportunities to improve provider use are identified, such as better data quality and integration with workflow. Key findings and lessons for advancing HIE are identified.
CONCLUSIONS: VLER Health Exchange has made great strides in advancing HIE nationally by addressing important technical and policy issues that have impeded scalability, and by increasing trust and confidence in the value and accuracy of HIE among users. VLER Health Exchange has advanced HIE interoperability standards and patient consent policies nationally. Policy, programmatic, technology, and health Information Technology (IT) standards implications to advance HIE for improved delivery and coordination of health care are discussed. The pilot phase success led to VA-wide deployment of this data sharing capability in 2013.

Campion Jr TR, Vest JR, Ancker JS, Kaushal R, Investigators H. **Patient encounters and care transitions in one community supported by automated query-based health information exchange**. Amia 2013;Annual Symposium proceedings / AMIA Symposium. AMIA Symposium. 2013:175-184.
Abstract: Care transitions from one facility to another threaten patient safety due to the potential loss of critical clinical information. Electronic clinical data exchange may address the problem. Approaches to exchange range from manual directed exchange, or sending point-to-point messages, to automated query-based health information exchange (HIE), or aggregating data from multiple sources. In this study, we measured the extent to which automated query-based HIE supported patient encounters and care transitions in one community. During the 23-month study period, 41% (n=33,219) of affirmatively consented patients had at least one encounter supported by automated query-based HIE. Of these patients, 41% (n=13,685) visited two or more facilities and accounted for 68% of total encounters. Of total encounters, 28% (n=40,828) were care transitions from one facility to another. Findings suggest that automated query-based HIE may support care transitions with efficient information sharing and assist United States providers in achieving stage two of meaningful use.

Carr CM, Krywko DM, Moore HE, Saef SH. **The impact of a health information exchange on the management of patients in an urban academic emergency department: An observational study and cost analysis**. Ann Emerg Med 2012;1):S15.
Abstract: Study Objectives: Perform a pilot study investigating the ability of a Health Information Exchange (HIE) to avoid unnecessary testing and treatment for patients in an urban, academic emergency department (ED). Perform a cost analysis evaluating the impact that HIE use in the ED may have on institutional costs. Methods: The study site was the ED at an urban, academic medical center. The study design was observational, prospective using a voluntary, anonymous survey. Eligible participants included Attending Physicians, Residents, Mid-Level Providers (PA & NP), Medical and PA students. Survey items addressed whether information from the HIE avoided the use of resources. Items used branching logic to ascertain specific types of services avoided. Additional items asked how use of the HIE affected quality of care and length of stay. The survey was automated using a survey construction tool (REDCap Survey Software © 2010 Vanderbilt University). A cost analysis was performed by multiplying the cost of services by the numbers and types of services reported as avoided. Costs for radiology studies were obtained from the Dept. of Radiology at the study site. Costs for laboratory studies were obtained from the Dept. of Pathology at the study site. Average cost of an admission from the ED was based on direct cost trends for ED admissions at the study site for 2011. Consultation fees were based on Medicare-allowable reimbursements. Results: During the 4-month study period from August through December of 2011 we had 18,529 patient encounters and 998 logons to the HIE (participation rate of 5.39%) by 60 clinicians at the study site. We collected 138 surveys representing 13.8% of logons. Of these, 105 (10.5% of logons) had information available in the HIE. Within this group the following services and costs were reported to be avoided [type of service avoided: percentage of participants for whom the service was avoided; cost of services avoided]: Laboratory/Microbiology: 30.5%; $462.85, Radiology studies: 47.6%; $160,893.00, Consultations: 19%; $3,990.00, Admission: 11.4%; $118,131.84. Cost analysis based on reported services avoided showed a savings of $283,477.69. Changes in management other than avoidance of a service were reported by 35% of participants. Participants stated that the quality of care delivered was improved for 86.7% of patients with information in the HIE. Eighty-one percent of participants reported that valuable time was saved with a mean time saved of 120.8 minutes. Conclusion: Observational data provided by ED clinicians in a urban academic medical center showed a noteworthy reduction in resource use as a result of having access to a regional HIE. Cost analysis based on reported

resource avoidance showed a savings of $283,477.69 with the principal contributions coming from avoided radiologic studies and admissions. Participants reported that valuable time was saved and quality of care was improved for over 80% of patients who had information in the HIE. Additional savings may be realized through improved put-through times and increased use of our HIE. Limitations include the observational nature of the study, selection bias, the Hawthorne effect, and cost estimates from a single institution. Allowance was not made for increased costs from additional services used because of information obtained from the HIE.

Chan TC, Killeen JP, Castillo EM, Lee J. **San diego safety net health information exchange**. Ann Emerg Med 2011;1):S310.
Abstract: Study Objectives: The original project goal for the San Diego Safety Net Health Information Exchange was to develop and implement an health information exchange between community clinics, dmergency departments (EDs), and hospitals to create a real-time, protected health information exchange accessible to providers at all levels (hospital, EDs, and clinics) at the point of patient care. Methods: Electronic referrals are for patients seen in the inpatient setting and ED without primary care who lived in areas served by the partner clinic network. The electronic referrals were conducted at the point of care in the ED such that patients received their referral and appointment prior to discharge from the hospital. Once the patient arrives at that appointment and it is entered into the system, the clinic provider will have access to the ED chart in PDF format. They will also have access to any subsequent ED visits as long as they are designated as their health care provider. Community clinic referrals for specialty care were also tracked. Descriptive statistics are presented. Results: For hospital to clinic referrals, there have been 507 Web-based referrals from the ED to the community clinics. The normal show rate for the clinic population is about 30-40%. The show rate for patients who were referred to clinics was about 12%. There were 318 orders for follow-up visits from inpatient services to participating clinics. A total of 16 of these referrals were specific appointments for patients with no primary care providers. As with ED referrals, once the patient make the visits, all current and subsequent inpatient visits notes are available to the clinic providers for all UCSD patients who have the clinic or specific provider listed as the patients primary care provider. Similarly, during this period the community clinics referred patients to UCSD for specialty care. A total of 51 patients seen in the community clinics were referred electronically to UCSD subspecialty clinics for specialty consultation and evaluation. Conclusion: This pilot was successful in linking an academic medical center with local community clinics for patient referrals and data exchange.

Dixon BE, Grannis SJ, Revere D. **Measuring the impact of a health information exchange intervention on provider-based notifiable disease reporting using mixed methods: a study protocol**. BMC Med Inform Decis Mak 2013;13:121.
Abstract: Health information exchange (HIE) is the electronic sharing of data and information between clinical care and public health entities. Previous research has shown that using HIE to electronically report laboratory results to public health can improve surveillance practice, yet there has been little utilization of HIE for improving provider-based disease reporting. This article describes a study protocol that uses mixed methods to evaluate an intervention to electronically pre-populate provider-based notifiable disease case reporting forms with clinical, laboratory and patient data available through an operational HIE. The evaluation seeks to: (1) identify barriers and facilitators to implementation, adoption and utilization of the intervention; (2) measure impacts on workflow, provider awareness, and end-user satisfaction; and (3) describe the contextual factors that impact the effectiveness of the intervention within heterogeneous clinical settings and the HIE. The intervention will be implemented over a staggered schedule in one of the largest and oldest

HIE infrastructures in the U.S., the Indiana Network for Patient Care. Evaluation will be conducted utilizing a concurrent design mixed methods framework in which qualitative methods are embedded within the quantitative methods. Quantitative data will include reporting rates, timeliness and burden and report completeness and accuracy, analyzed using interrupted time-series and other pre-post comparisons. Qualitative data regarding pre-post provider perceptions of report completeness, accuracy, and timeliness, reporting burden, data quality, benefits, utility, adoption, utilization and impact on reporting workflow will be collected using semi-structured interviews and open-ended survey items. Data will be triangulated to find convergence or agreement by cross-validating results to produce a contextualized portrayal of the facilitators and barriers to implementation and use of the intervention. By applying mixed research methods and measuring context, facilitators and barriers, and individual, organizational and data quality factors that may impact adoption and utilization of the intervention, we will document whether and how the intervention streamlines provider-based manual reporting workflows, lowers barriers to reporting, increases data completeness, improves reporting timeliness and captures a greater portion of communicable disease burden in the community.

Fidahussein M, Hook J, Kesterson J, Were M. **Using a regional health information exchange to improve identification of post-discharge follow-up providers**. J Gen Intern Med 2011;26:S163-S164.
Abstract: BACKGROUND: Determining who patients should follow-up with postdischarge is a key step in transitioning care froman inpatient to outpatient setting. Typically, this follow-up provider information is contained within the discharge summary, and inpatient providers rely greatly on it to determine who to communicate the patient's hospital course, discharge summary, and any test results returning after discharge. Unfortunately, no studies exist that evaluate how complete and accurate the follow-up information documented in discharge summaries is, and whether strategies exist to improve identification of the providers who discharged patients actually follow-up with after hospitalization. We set out to determine (a) the follow-up patterns of patients discharged from two large hospitals in central Indiana, and (b) the potential role of a regional health information exchange (RHIE) in improving identification of the providers with whom these patients follow-up with post-discharge. METHODS: We performed this study at two large urban Midwestern hospitals (Hospital A and Hospital B) which are served by comprehensive electronic health record systems (EHRs) and which participate in the Indiana Network for Patient Care (INPC) RHIE. The study involved 679 randomly-selected patients (306 from Hospital A and 373 from Hospital B) who were admitted to the General Internal Medicine Hospitalist Services (GIMHS) teams during Jan-Feb 2009 at these institutions. Discharge summaries for the study patients were each reviewed independently by two physicians who abstracted the names of the intended follow-up providers that were mentioned in the summaries. If there were disagreements between the reviewers on whether a particular follow-up provider was mentioned, the reviewers discussed the case to achieve consensus. Electronically stored encounter data from the INPC were also queried to extract all outpatient physician encounter data for the study patients that occurred 12-14 months prior to the relevant admission and 3-5 months after discharge (Jan 1, 2008 - Jun 1, 2009). Using this data, we determined the frequency with which patients actually followed up with the intended outpatient providers, and also with other providers who were not mentioned in the discharge summary. We also determined how often historical visit information contained in the RHIE could be used to inform likely outpatient followup providers for patients, especially when no information about the follow-up providers was available in the discharge summary. RESULTS: Of the 679 study patients, 458 (67%, [180, 59% Hospital A & 278, 75% Hospital B]) had at least one follow-up provider mentioned in the discharge summary, with the other 221 (33%, [126, 41% Hospital A & 95, 25% Hospital B]) having no

follow-up provider mentioned. Of the 458 patients with a provider mentioned in the discharge summary, 185 (40%, [84, 47% Hospital A & 101, 36% Hospital B]) followed-up in clinic with at least one of the mentioned providers, 132 (29%, [61, 34% Hospital A & 71, 26% Hospital B]) followed-up with none of the providers mentioned in the summary, and 141 (31%, [35, 19% Hospital A & 106, 38% Hospital B]) did not follow-up with any provider. Historical encounter information from the RHIE revealed that of the 317 patients who had a follow-up provider mentioned in the discharge summary and who followed-up post-discharge with any provider, 182 (57%, [83, 57% Hospital A & 99, 58% Hospital B]) followed with at least one of the same providers they had been seeing prior to admission. Of the 123 patients who did not have any follow-up providers mentioned in the discharge summary but still followed-up post-discharge with any provider, 58 (47%, [43, 52% Hospital A & 15, 16%Hospital B]) followed-up with at least one of the same providers they had been seeing prior to admission. Overall, of the 440 patients who had a clinic visit post-discharge, 240 (55%, [126, 55% Hospital A & 114, 55% Hospital B]) saw at least one of the same providers they had visited with prior to their admission. Of the 458 patients that h d at least one follow-up provider mentioned in the discharge summary, 182 (40%, [74, 41%Hospital A & 108, 39%Hospital B]) were seeing at least one of these providers prior to admission. Of these 182 patients, 94 (52%, [43, 58% Hospital A & 51, 47% Hospital B]) followed-up with the at least one of the same providers post-discharge. CONCLUSION: A care system which relies largely on follow-up provider information contained within discharge summaries is highly inadequate at identifying the actual providers patients follow up with after they are discharged from the hospital. We found that 33% of discharged patients had no follow-up providers identified. Even when follow-up providers were mentioned in the discharge summary, almost a third of the patients still saw other providers. Regional Health Information Exchanges, which contain encounter information that occur after hospital discharge, offer a valuable resource in improving identification of the true follow-up providers for patients discharged from the hospital. Additionally, historical visit information within these systems can help predict who the likely postdischarge follow-up provider will be for patients being discharged from the hospital. We observed that more than half of the patients actually followed up with a provider they had seen prior to the admission. Making this historical provider information available during discharge planning could potentially increase the likelihood that the right follow-up providers will be identified at the time of a patient's hospital discharge.

Foglia RP, Alder AC, Ruiz G. **Improving perioperative performance: the use of operations management and the electronic health record**. J Pediatr Surg 2013;48(1):95-98.

Abstract: PURPOSE: Perioperative services require the orchestration of multiple staff, space and equipment. Our aim was to identify whether the implementation of operations management and an electronic health record (EHR) improved perioperative performance. METHODS: We compared 2006, pre operations management and EHR implementation, to 2010, post implementation. Operations management consisted of: communication to staff of perioperative vision and metrics, obtaining credible data and analysis, and the implementation of performance improvement processes. The EHR allows: identification of delays and the accountable service or person, collection and collation of data for analysis in multiple venues, including operational, financial, and quality. Metrics assessed included: operative cases, first case on time starts; reason for delay, and operating revenue. RESULTS: In 2006, 19,148 operations were performed (13,545 in the Main Operating Room (OR) area, and 5603, at satellite locations); first case on time starts were 12%; reasons for first case delay were not identifiable; and operating revenue was $115.8M overall, with $78.1M in the Main OR area. In 2010, cases increased to 25,856 (+35%); Main OR area increased to 13,986 (+3%); first case on time starts improved to 46%; operations outside the

Main OR area increased to 11,870 (112%); case delays were ascribed to nurses 7%, anesthesiologists 22%, surgeons 33%, and other (patient, hospital) 38%. Five surgeons (7%) accounted for 29% of surgical delays and 4 anesthesiologists (8%) for 45% of anesthesiology delays; operating revenue increased to $177.3M (+53%) overall, and in the Main OR area rose to $101.5M (+30%).
CONCLUSIONS: The use of operations management and EHR resulted in improved processes, credible data, promptly sharing the metrics, and pinpointing individual provider performance. Implementation of these strategies allowed us to shift cases between facilities, reallocate OR blocks, increase first case on time starts four fold and operative cases by 35%, and these changes were associated with a 53% increase in operating revenue. The fact that revenue increase was greater than case volume (53% vs. 35%) speaks for improved performance.

Frisse ME, Johnson KB, Nian H, Davison CL, Gadd CS, Unertl KM, et al. **The financial impact of health information exchange on emergency department care**. J Am Med Inform Assoc 2012;19(3):328-333.
Abstract: Objective: To examine the financial impact health information exchange (HIE) in emergency departments (EDs). Materials and Methods: We studied all ED encounters over a 13-month period in which HIE data were accessed in all major emergency departments Memphis, Tennessee. HIE access encounter records were matched with similar encounter records without HIE access. Outcomes studied were ED-originated hospital admissions, admissions for observation, laboratory testing, head CT, body CT, ankle radiographs, chest radiographs, and echocardiograms. Our estimates employed generalized estimating equations for logistic regression models adjusted for admission type, length of stay, and Charlson co-morbidity index. Marginal probabilities were used to calculate changes in outcome variables and their financial consequences. Results: HIE data were accessed in approximately 6.8% of ED visits across 12 EDs studied. In 11 EDs directly accessing HIE data only through a secure Web browser, access was associated with a decrease in hospital admissions (adjusted odds ratio (OR)=0.27; p<0001). In a 12th ED relying more on print summaries, HIE access was associated with a decrease in hospital admissions (OR=0.48; p<0001) and statistically significant decreases in head CT use, body CT use, and laboratory test ordering. Discussion: Applied only to the study population, HIE access was associated with an annual cost savings of $1.9 million. Net of annual operating costs, HIE access reduced overall costs by $1.07 million. Hospital admission reductions accounted for 97.6% of total cost reductions. Conclusion: Access to additional clinical data through HIE in emergency department settings is associated with net societal saving.

Garrelts JC, Gagnon M, Eisenberg C, Moerer J, Carrithers J. **Impact of telepharmacy in a multihospital health system**. Am J Health Syst Pharm 2010;67(17):1456-1462.
Abstract: PURPOSE: The impact of telepharmacy in a multihospital health system was evaluated.
SUMMARY: Telepharmacy services were implemented at five hospitals within a Catholic, nonprofit, integrated delivery network health system. Telepharmacy services were provided by seven pharmacists employed by the health system. Using a virtual private network or terminal server, pharmacists directly accessed hospital servers and information systems to conduct their work. Telephone calls were automatically routed to the telepharmacist so that handling of nursing and other calls would be transparent to staff. Hours of telepharmacy service were 5 p.m. to 2 a.m. Monday through Friday evenings at four of the hospitals and 8 p.m. to 10 p.m. at the rural hospital. Order-processing time for routine orders was reduced from 26.8 to 14 minutes ($p < 0.0001$), while stat order processing was shortened from 11.6 to 8.8 minutes ($p = 0.007$). For routine orders, turnaround times greater than 60 minutes became almost nonexistent after telepharmacy services were implemented. The number of clinical interventions documented increased by 42%, from 619

to 881, equivalent to a net annualized saving of $1,132,144. A significant improvement in nurses' global satisfaction with pharmacist availability for unit consultations was reported (3.0 versus 4.0 on a 5.0 Likert scale; p = 0.028).
CONCLUSION: The implementation of telepharmacy services in a multihospital health system expanded hours of service, improved the speed of processing of physician medication orders, and increased clinical pharmacy services and cost avoidance. Surveys of health care staff found that telepharmacy services were well received.

Graetz I, Reed M, Shortell SM, Rundall TG, Bellows J, Hsu J. **The next step towards making use meaningful: electronic information exchange and care coordination across clinicians and delivery sites**. Med Care 2014;52(12):1037-1041.
Abstract: BACKGROUND: Care for patients with chronic conditions often requires coordination between multiple physicians and delivery sites. Electronic Health Record (EHR) use could improve care quality and efficiency in part by facilitating care coordination. OBJECTIVE: We examined the association between EHR use and clinician perceptions of care coordination for patients transferred across clinicians and delivery sites. RESEARCH DESIGN: Repeated surveys of primary care clinicians during the staggered implementation of an outpatient EHR (2005-2008), followed by an integrated inpatient EHR (2006-2010). We measured the association between EHR use stages (no use, outpatient EHR only, and integrated inpatient-outpatient EHR) and care coordination using logistic regression, adjusting for clinician characteristics, study year, and medical center. SUBJECTS: Adult primary care clinicians in a large Integrated Delivery System. MEASURES: Three measures of clinician-reported care coordination for patient care transferred across clinicians (eg, from specialist to primary care team) and across delivery sites (eg, from the hospital to outpatient care). RESULTS: Outpatient EHR use was associated with higher reports of access to complete and timely clinical information and higher agreement on clinician roles and responsibilities for patients transferred across clinicians, but not for patients transferred across delivery sites. Use of the integrated outpatient-inpatient EHR was associated with higher reports of access to timely and complete clinical information, clinician agreement on the patient's treatment plan for patients transferred across delivery sites, and with all coordination measures for patients transferred across clinicians. CONCLUSION: Use of an integrated EHR with health information exchange across delivery settings improved patient care coordination.

Haggstrom D, Myers LJ, French DD, Barnd J, Rosenman M, Kesterson J, et al. **Impact of VA health information exchange upon the quality of diabetes care**. J Gen Intern Med 2014;29:S122.
Abstract: BACKGROUND: Like most health care systems, the VA often has patients who receive some portion of their care outside the VA. Due to the lack of interoperability among electronic health record systems, providers caring for veterans who are receiving services outside the VA may not have timely access to important information about their patients. Health information exchange (HIE) advocates believe that greater interoperability will improve the quality of care. In this study, measures of ambulatory care quality were chosen that an expert panel suggests may be sensitive to the effect of HIE, and feasible for electronic data capture. METHODS: Intervention: A regional VA-HIE demonstration program was conducted through a national initiative called the Virtual Lifetime Electronic Record (VLER). The VA-HIE performed secure, bi-directional health information exchange between the VA and community partners organized together through the Indiana Network for Patient Care. Health care providers inside and outside the VA were able to access exchanged data. Patients were enrolled in the VA-HIE program on-site at the Indianapolis VA in outpatient clinics or through the release-of-information office. Study design: A pre-post cohort evaluation of the VA-HIE program was performed, with a concurrent control group.

For the evaluation, data on care received by patients inside and outside the VA were obtained for 1 year before, and 1 year after, the index date of patient enrollment. To allow for program implementation lag time and enable providers to become accustomed to using HIE data, the first study patients were enrolled in the cohort 3 months after VA-HIE implementation. All control patients were enrolled 3 months after VA-HIE implementation. Population: Patients with diabetes (at least 2 diagnoses) were included in the evaluation. Patients were included if they had at least 1 clinical encounter at the Indianapolis VA over a 1-year period prior to the index date. Overall, 9,612 patients diagnosed with diabetes were followed: 1,768 enrolled in the VA-HIE intervention and 7,844 in the control group. Measures/Analyses: For hemoglobin A1c (HgA1c), both the mean lab values and the proportion of diabetics with HgA1c <9 % were measured. For LDL, the mean lab values, and the proportions of diabetics with LDL<130 and LDL<100 were measured. Multivariable regression models were constructed as a function of VA-HIE intervention status, time, and baseline covariates (race/ethnicity, insurance, marital status, Charlson comorbidity index, and service-connected disability). RESULTS: The mean age (62.4 years) and race (27 % non-white) were no different between intervention and control groups. However, there were statistically significant differences between the VA-HIE intervention and control groups in the proportion insured (66 % vs. 64 %), married (63 % vs. 58 %), comorbidity index (0.62 vs. 0.39) and with service-connected disability (85 % vs. 82 %). The sources of the diabetes diagnostic information were the VA (80 %), community partners (3%), or both (16 %) electronic data systems. Among the diabetes population, the VA-HIE had no significant effect over time on the mean HgA1c value or the proportion of patients with HgA1c <9 %. For all of the LDL measures, there were significant effects of both the VA-HIE intervention and time (Figure 1), but the interaction effect was not significant. CONCLUSIONS: Providers of patients enrolled in the VA-HIE had better access to data residing in non-VA health care systems. About 1 in 5 veteran patients had data identifying diabetes diagnoses in non-VA electronic data systems. The VA-HIE program had no measureable effect upon the quality of diabetes care. Possible reasons for the lack of effect may be that HIE does not influence these types of care management processes, the amount of data shared with the VA was not sufficient to affect care quality, or the evaluation was performed early in the implementation or diffusion of the VA-HIE. (Figure presented).

Hebel E, Middleton B, Shubina M, Turchin A. **Bridging the chasm: effect of health information exchange on volume of laboratory testing**. Arch Intern Med 2012;172(6):517-519.

Abstract:

Kazimierczak A, Cnotliwy M, Gutowski P, Sledz M, Guzicka-Kazimierczak R, Jewiarz A. **The advantages of the introduction of a medical electronic file system in vascular surgery. [Polish, English]**. Acta Angiologica 2011;17(2):158-172.

Abstract: Background. A rising number of claims against hospitals and the lack of a standardized consent form based on individual calculations of death and complications is a growing problem in Poland. Aim: Evaluation of the usefulness of the Medical Electronic File System (ESDM) in clinical practice on the Vascular Surgery Ward. Accuracy evaluation of the P-POSSUM scale as a tool supplying detailed risk calculation for the patient consent form. Material and methods. A comparison of the time consumption of the two parallel patient's medical file systems (electronic and classic/paper) done on 50 elective cases. Evaluation of the predictive accuracy of the P-POSSUM scale in a group of 1270 patients treated in the Vascular Surgery Department of Pomerania University during one year. A prospective comparison of the time taken in dealing with the two systems of medical data files (electronic versus paper). Statistical (Statistica PL) assessment of the accuracy of the P-POSSUM risk calculator and searching for new predictors of early death in Vascular Surgery. Results. The Medical Electronic File System (ESDM) was certified with ISO (hospital

quality standard). It allowed a saving of almost half the time for dealing with medical files (14 hours and 6 minutes versus 7 hours and 53 minutes). The time consumed in doctors' paperwork has been decreased by about 30 per cent (3 hours and 43 minutes versus 2 hours and 42 minutes) and the quality of the paperwork has been improved. We confirmed the clinical effectiveness of P-POSSUM as well as ASA scale in vascular surgery. Additional multifactor analysis of early death predictors shows the independent influence of the new factors never used in calculators, e.g. glomellular filtration rate (GFR) beloved 30 ml/min/1.73 msq (p = 0.0014), systemic inflamatory response syndrome (SIRS) (p = 0.00078), critical limb ischaemia (p = 0.000039), acute limb ischaemia (p = 0.000001). Conclusions. 1. Introduction of the Medical Electronic File System (ESDM) in the Vascular Surgery Department of Pomerania Medical University in Szczecin has improved the quality of medical files and greatly reduces the paperwork time. 2. The P-POSSUM calculator is suitable for risk assessment in Vascular Surgery but, due to the progress in medicine, might need to be refreshed. 3. The creation of the National Vascular Surgery Register (KRON) might support work on the suitable risk calculator for "vascular patent" and allow comparison of the results between the sites and the surgeons in Poland.

Kern L, Barron Y, Dhopeshwarkar R, Kaushal R. **Health information exchange and quality of care**. J Gen Intern Med 2011;26:S167.

Abstract: BACKGROUND: Health information exchange, or the electronic sharing of clinical data across health care providers, has become a national priority. However, evidence on the effectiveness of health information exchange has been limited. We previously found, in a cross-sectional study, that health information exchange was associated with higher ambulatory quality of care. However, it was not possible in that study to rule out confounding by physicians' baseline quality of care. This study was designed to address that limitation. Our objective was to determine any association between health information exchange and quality of care, adjusting for baseline quality of care. METHODS: We conducted a longitudinal cohort study over two years (Clinicaltrials.gov Registration #NCT00225563). We included primary care physicians in the Taconic Independent Practice Association in the Hudson Valley region of New York State. We included all of those primary care physicians who had at least 150 patients with MVP Healthcare and had quality data at baseline and follow-up. All physicians had access to an electronic portal, through which physicians could view test results, radiology reports, discharge summaries and other reports for their patients over time, regardless of the ordering physician. We used usage of the portal as the independent variable. For the dependent variable, we used health care quality at follow-up, as measured by 13 metrics from the Health Plan Employer Data and Information Set (HEDIS) and 2 patient satisfaction metrics. We used generalized estimation equations to measure associations between usage and quality at followup, adjusting for 11 physician characteristics (including adoption of electronic health records, case mix, resource utilization and health care quality at baseline). RESULTS: We included 138 primary care physicians. The mean practice size was 4 physicians per practice. Nearly half (43%) of the physicians were users of the portal. Non-users performed at or above average for 51% of the quality metrics at both baseline and follow-up (p=1.00). Users performed at or above average for 57% of the quality metrics at baseline and 64% at follow-up (p=0.06), a relative improvement of 12%. Adjusting for physician characteristics and baseline quality, use of the portal was independently associated with higher quality of care at follow up (Odds Ratio 1.42; 95% Confidence Interval 1.04, 1.95; p=0.03). CONCLUSION: Health information exchange, which is presently being encouraged by federal incentives, was associated with modest improvements in ambulatory quality.

Maenpaa T, Asikainen P, Gissler M, Siponen K, Maass M, Saranto K, et al. **The utilization**

rate of the regional health information exchange: how it impacts on health care delivery outcomes. Journal of public health management and practice : JPHMP 2012;18(3):215-223.
Abstract: Interest in improving quality and effectiveness is the primary driver for health information exchange efforts across a health care system to improve the provision of public health care services. The aim here was to describe and identify the impact of a regional health information exchange (HIE) using quantitative statistics for 2004-2008 in one hospital district in Finland. We conducted a comparative, longitudinal 5-year follow-up study to evaluate the utilization rates of HIE, and the impact on health care delivery outcomes. The selected outcomes were total laboratory tests, radiology examinations, appointments, emergency visits, and referrals. The HIE utilization rates increased annually in all 10 federations of municipalities, and the viewing of reference information increased steadily in each professional group over the 5-year study period. In these federations, a significant connection was found to the number of laboratory tests and radiology examinations, with a statistically significant increase in the number of viewed references and use of HIE. The higher the numbers of emergency visits and appointments, the higher the numbers of emergency referrals to specialized care, viewed references, and HIE usage among the groups of different health care professionals. There is increasing interest in HIE usage through regional health information system among health professionals to improve health care delivery regionally and bring information on the patient directly to care delivery. It will be important to study which changes in working methods in the service system are explained by RHIS. Also, the experiences of the change that has taken place should be studied among the different stakeholders, administrative representatives, and patients.

McCullough JS, Casey M, Moscovice I, Prasad S. **The effect of health information technology on quality in U.S. hospitals**. Health Aff (Millwood) 2010;29(4):647-654.
Abstract: Health information technology (IT), such as computerized physician order entry and electronic health records, has potential to improve the quality of health care. But the returns from widespread adoption of such technologies remain uncertain. We measured changes in the quality of care following adoption of electronic health records among a national sample of U.S. hospitals from 2004 to 2007. The use of computerized physician order entry and electronic health records resulted in significant improvements in two quality measures, with larger effects in academic than nonacademic hospitals. We conclude that achieving substantive benefits from national implementation of health IT may be a lengthy process. Policies to improve health IT's efficacy in nonacademic hospitals might be more beneficial than adoption subsidies.

Parker RF, Mohamed AZ, Hassoun SA, Miles S, Fernando DJ. **The effect of using a shared electronic health record on quality of care in people with type 2 diabetes**. J Diabetes Sci Technol 2014;8(5):1064-1065.
Abstract:

Politi L, Codish S, Sagy I, Fink L. **Use patterns of health information exchange through a multidimensional lens: conceptual framework and empirical validation**. Journal of Biomedical Informatics 2014;52:212-221.
Abstract: Insights about patterns of system use are often gained through the analysis of system log files, which record the actual behavior of users. In a clinical context, however, few attempts have been made to typify system use through log file analysis. The present study offers a framework for identifying, describing, and discerning among patterns of use of a clinical information retrieval system. We use the session attributes of volume, diversity, granularity, duration, and content to define a multidimensional space in which each specific session can be positioned. We also describe an analytical method for identifying the common archetypes of system use in this multidimensional space. We demonstrate

the value of the proposed framework with a log file of the use of a health information exchange (HIE) system by physicians in an emergency department (ED) of a large Israeli hospital. The analysis reveals five distinct patterns of system use, which have yet to be described in the relevant literature. The results of this study have the potential to inform the design of HIE systems for efficient and effective use, thus increasing their contribution to the clinical decision-making process.

Redd TK, Read-Brown S, Choi D, Yackel TR, Tu DC, Chiang MF. **Electronic health record impact on productivity and efficiency in an academic pediatric ophthalmology practice**. J AAPOS 2014;18(6):584-589.
Abstract: Purpose To measure the effect of electronic health record (EHR) implementation on productivity and efficiency in the pediatric ophthalmology division at an academic medical center. Methods Four established providers were selected from the pediatric ophthalmology division at the Oregon Health & Science University Casey Eye Institute. Clinical volume was compared before and after EHR implementation for each provider. Time elapsed from chart open to completion (OTC time) and the proportion of charts completed during business hours were monitored for 3 years following implementation. Results Overall there was an 11% decrease in clinical volume following EHR implementation, which was not statistically significant (P = 0.18). The mean OTC time ranged from 5.5 to 28.3 hours among providers in this study, and trends over time were variable among the four providers. Forty-four percent of all charts were closed outside normal business hours (30% on weekdays, 14% on weekends). Conclusions EHR implementation was associated with a negative impact on productivity and efficiency in our pediatric ophthalmology division.

Reed M, Huang J, Brand R, Graetz I, Neugebauer R, Fireman B, et al. **Implementation of an outpatient electronic health record and emergency department visits, hospitalizations, and office visits among patients with diabetes**. JAMA - Journal of the American Medical Association 2013;310(10):1060-1065.
Abstract: IMPORTANCE: The US federal government is spending billions of dollars in physician incentives to encourage the meaningful use of electronic health records (EHRs). Although the use of EHRs has potential to improve patient health outcomes, the existing evidence has been limited and inconsistent. OBJECTIVE: To examine the association between implementing a commercially available outpatient EHR and emergency department (ED) visits, hospitalizations, and office visits for patients with diabetes mellitus. DESIGN, SETTING, AND POPULATION: Staggered EHR implementation across outpatient clinics in an integrated delivery system (Kaiser Permanente Northern California) between 2005 and 2008 created an opportunity for studying changes associated with EHR use. Among a population-based sample of 169 711 patients with diabetes between 2004 and 2009, we analyzed 4 997 585 person-months before EHR implementation and 4 648 572 person-months after an EHR was being used by patients' physicians. MAIN OUTCOMES AND MEASURES: We examined the association between EHR use and unfavorable clinical events (ED visits and hospitalizations) and office visit use among patients with diabetes, using multivariable regression with patient-level fixed-effect analyses and adjustment for trends over time. RESULTS: In multivariable analyses, use of the EHR was associated with a statistically significantly decreased number of ED visits, 28.80 fewer visits per 1000 patients annually (95% CI, 20.28 to 37.32), from a mean of 519.12 visits per 1000 patients annually without using the EHR to 490.32 per 1000 patients when using the EHR. The EHR was also associated with 13.10 fewer hospitalizations per 1000 patients annually (95% CI, 7.37 to 18.82), from a mean of 251.60 hospitalizations per 1000 patients annually with no EHR to 238.50 per 1000 patients annually when using the EHR. There were similar statistically significant reductions in nonelective hospitalizations (10.92 fewer per 1000 patients annually) and hospitalizations for ambulatory care-sensitive conditions (7.08 fewer per 1000 patients

annually). There was no statistically significant association between EHR use and office visit rates. CONCLUSIONS AND RELEVANCE: Among patients with diabetes, use of an outpatient EHR in an integrated delivery system was associated with modest reductions in ED visits and hospitalizations but not office visit rates. Further studies are needed to quantify the association of EHR use with changes in costs.

Roberts LL, Ward MM, Brokel JM, Wakefield DS, Crandall DK, Conlon P. **Impact of health information technology on detection of potential adverse drug events at the ordering stage**. Am J Health Syst Pharm 2010;67(21):1838-1846.
Abstract: PURPOSE: The impact of implementing commercially available health care information technologies at hospitals in a large health system on the identification of potential adverse drug events (ADEs) at the medication ordering stage was studied.
METHODS: All hospitals in the health system had implemented a clinical decision-support system (CDSS) consisting of a centralized clinical data repository, interfaces for reports, a results reviewer, and a package of ADE alert rules. Additional technology including computerized provider order entry (CPOE), an advanced CDSS, and evidence-based order sets was implemented in nine hospitals. ADE alerts at these hospitals were compared with alerts at nine hospitals without the advanced technology. A linear mixed-effects model was used in determining the mean response profile of six dependent variables over 28 total months for each experimental group.
RESULTS: Overall, hospitals with CPOE and an advanced CDSS captured significantly more ADE alerts for pharmacist review; an average of 336 additional potential ADEs per month per hospital were reviewed. Pharmacists identified some 94% of the alerts as false positives. Alerts identified as potentially true positives were reviewed with physicians, and order changes were recommended. The number of true-positive alerts per 1000 admissions increased.
CONCLUSION: The implementation of CPOE and advanced CDSS tools significantly increased the number of potential ADE alerts for pharmacist review and the number of true-positive ADE alerts identified per 1000 admissions.

Saef SH, Melvin CL, Carr CM. **Impact of a health information exchange on resource use and Medicare-allowable reimbursements at 11 emergency departments in a midsized city**. West J Emerg Med 2014;15(7):777-785.
Abstract: Introduction Use clinician perceptions to estimate the impact of a health information exchange (HIE) on emergency department (ED) care at four major hospital systems (HS) within a region. Use survey data provided by ED clinicians to estimate reduction in Medicare-allowable reimbursements (MARs) resulting from use of an HIE. Methods: We conducted the study during a one-year period beginning in February 2012. Study sites included eleven EDs operated by four major HS in the region of a mid-sized Southeastern city, including one academic ED, five community hospital EDs, four free-standing EDs and 1 ED/Chest Pain Center (CPC) all of which participated in an HIE. The study design was observational, prospective using a voluntary, anonymous, online survey. Eligible participants included attending emergency physicians, residents and mid-level providers (PA & NP). Survey items asked clinicians whether information obtained from the HIE changed resource use while caring for patients at the study sites and used branching logic to ascertain specific types of services avoided including laboratory/microbiology, radiology, consultations and hospital admissions. Additional items asked how use of the HIE affected quality of care and length of stay. The survey was automated using a survey construction tool (REDCap Survey Software © 2010 Vanderbilt University). We calculated avoided MARs by multiplying the numbers and types of services reported to have been avoided. Average cost of an admission from the ED was based on direct cost trends for ED admissions within the region. Results: During the 12-month study period we had 325,740 patient encounters and 7 525 logons to the HIE (utilization rate of 2.3%) by 231 ED clinicians practicing at the

study sites. We collected 621 surveys representing 8.25% of logons of which 532 (85.7% of surveys) reported on patients who had information available in the HIE. Within this group the following services and MARs were reported to have been avoided [type of service: number of services; MARs]: Laboratory/Microbiology:187; 2,073, Radiology: 298; 475,840, Consultations: 61; 6,461, Hospital Admissions: 56; 551,282. Grand total of MARs avoided: 1,035,654; average 1,947 per patient who had information available in the HIE (Range: 1,491- 2,395 between HS). Changes in management other than avoidance of a service were reported by 32.2% of participants. Participants stated that quality of care was improved for 89% of patients with information in the HIE. Eighty-two percent of participants reported that valuable time was saved with a mean time saved of 105 minutes. Conclusion: Observational data provided by ED clinicians practicing at eleven EDs in a mid-sized Southeastern city showed an average reduction in MARs of 1,947 per patient who had information available in an HIE. The majority of reduced MARs were due to avoided radiology studies and hospital admissions. Over 80% of participants reported that quality of care was improved and valuable time was saved.

Shah N, Wu C, Sood P, Puttarajappa C, Bernardo J, Mehta R, et al. **Improvement in quality of care metrics through the implementation of electronic health records (EHR) in renal transplant patient management**. Transplantation 2014;98:814-815.
Abstract: Objective: Present our experience with Electronic Health Records (EHR) in Clinical Decision Support (CDS), Computerized Physician Order Entry (CPOE), and Health Information Exchange (HIE) in renal transplant care. Methods: Apply EHR for standardized post transplant care A)Implement protocols and flow sheets 1) Establish unified template note and flow sheets (TX chemistry, TX anemia, Tx CVD risk, Tx virology, TX HLA) 2) Establish clinical pathways with CDS to detect allograft dysfunction, drug levels, DSA's, viral surveillance and protocol biopsies. 3) Manage CDC high risk organs recipients with viral monitoring. 4) Manage post-transplant viral infections (CMV, BKV) to reduce treatment variability and improve outcomes. B) Communication: Implement HIE to improve communication between patients and staff, immediate availability of lab results and medication refills through E-prescribing. Lab results download into patient charts with critical alerts. Patients received results via secure health track emails. C) Patient care: Improved monitoring for compliance with lab testing, medication refills and follow up. Periodic reports for "at risk patients" allowed focused interventions. D) Established a standardized note to reduce variability, decrease error, and improved the quality of care. Results: At our center we performed 192 kidney alone transplants in 2013 and achieved 100% compliance with chemistry testing monitoring, 90% BKV screening, and 78% protocol biopsy. We have unified patient care for BKV infection and acute allograft rejection. We noticed an improvement in 1-year actual allograft survival (Figure) with 6m allograft survival of 98% (transplanted in 2013). Conclusion: Adopting a unified approach to patient care using EHR resulted in improvement in quality metrics via protocols and flow sheets, monitoring of compliance and better communications. The use of EHR has been associated with effective patient care with a trend towards better outcome. (Figure Presented).

Shapiro JS, Johnson SA, Angiollilo J, Fleischman W, Onyile A, Kuperman G. **Health information exchange improves identification of frequent emergency department users**. Health Aff (Millwood) 2013;32(12):2193-2198.
Abstract: We hypothesized that using communitywide data from a health information exchange (HIE) could improve the ability to identify frequent emergency department (ED) users-those with four or more ED visits in thirty days-by allowing ED use to be measured across unaffiliated hospitals. When we analyzed HIE-wide data instead of site-specific data, we identified 20.3 percent more frequent ED users (5,756 versus 4,785) and 16.0 percent more visits by them to the ED (53,031 versus 45,771). Additionally, we found that 28.8 per-

cent of frequent ED users visited multiple EDs during the twelve-month study period, versus 3.0 percent of all ED users. All three differences were significant ($$p). An improved ability to identify frequent ED users allows better targeting of case management and other services that can improve frequent ED users' health and reduce their use of costly emergency medical services.

Shapiro JS, Onyile A, Patel VR, Strayer RJ, Kuperman G. **Enabling 72-hour emergency department returns measurement with regional data from a health information exchange**. Ann Emerg Med 2011;1):S295.
Abstract: Study Objective: To compare the measurements of 72-hour emergency department (ED) returns from an emergency department (ED) information system (EDIS) to data derived from a functioning health information exchange, the New York Clinical Information Exchange (NYCLIX). This comparison will help validate the use of health information exchange data for a more broad-based quality measure of returns across multiple EDs in New York City. Methods: We compared counts of 72-hour ED returns from 2 sources: 1) an EDIS vendor-supplied quality report and 2) NYCLIX data derived from a query designed to mimic the EDIS report format. Data from 01/01/2010 - 10beta1/2010 were obtained from both sources and analyzed. Results: For the study period, the average number of total ED visits per month from the EDIS was 8052.1 (SD 333.6). The average number of health information exchange 72-hour return visits per month was 725.9 (SD 49.1) while the average number of patients with 72-hour return visits was 324.3(SD 20.7). From the EDIS the average number of72-hour return visits was 643 (SD 42.7) and average number of patients with 72-hour returns visits was 301.6 (SD 18.6). The average difference between these 2 data sources was 11.4% when calculating 72-hour return visits and 7.0% when calculating patients with 72-hour return visits (see Table 1). On further analysis, the difference between the 2 data sources was of ten due to the following reasons, though these do not account for all discrepancies: 1) a difference in the time calculations for ED returns between NYCLIX and EDIS report (we did not have access to the exact algorithm used by the EDIS vendor); 2) medical record number (MRN) changes that were made in the hospital's registration system that propagated to NYCLIX but that did not get updated in EDIS; and 3) a difference between triage time (updating the EDIS) and registration time (updating NYCLIX), which placed some cases beyond the 72-hour window within 1 system and not the other. Conclusions: Health information exchange holds significant promise to expand ED quality measurements when trending for early returns. With the aid of health information exchange, 72-hour ED returns can be calculated across multiple institutions to more accurately reflect how ED patients use the health care system, making it a patient-centric rather than institution-centric measure. Additional work is needed to refine the HIE query and perform data cleaning steps before this can be operationalized across multiple EDs.

Tchwenko SN, Parnell H, Messer LC. **Health outcomes following a health information exchange intervention for HIV patients**. Am J Epidemiol 2012;175:S13.
Abstract: Data sharing through electronic networks (Health Information Exchange (HIE)) among HIV care agencies may improve the quality of HIV care. This study describes changes in quality- and health-related outcomes for HIV-positive persons following an HIE intervention. Using an Interrupted Time Series design, we conducted 1274 consecutive interviews in 76 twoweek intervals at Wake Forest University Health Sciences (2008-2011). The HIE went live (interruption) on December 1 2009 resulting in 42 preand 34 post-interruption time points. Full segmented regression models produced beta coefficients and 95% confidence intervals (95% CI) that estimated for each outcome, the discontinuity at the time of interruption as well as independent linear pre- and post-interruption trends. Study subjects had a mean age of 43.1 years; 57% were male, 73.4% Black and 71.4% at least high school educated. Following interruption, the percentage of clients adherent to

anti-retroviral (ARV) drugs rose by 4.5 points (95% CI: 3.4, 5.6). Case management services increased by 15 visits per 100 clients (95% CI: 14.1, 16.6) immediately after interruption and continued to rise by 1 visit per 100 clients (95% CI: 0.9, 1.2) per month thereafter. Cliniclevel CD4 count dropped by 36 cells (95% CI: -41.4, -30.8) right after interruption but rose by 2 cells (95% CI: 1.5, 2.5) per month thereafter versus 1.2 cells (95% CI: 1.0, 1.5) per month pre-interruption. Finally, clinic-level log viral load remained stable across the pre- and postinterruption time series. The HIE intervention has led to significant increases in ARV adherence and case management services. Although CD4 count level dropped immediately post-interruption, there was a stronger positive trend post- compared to pre- interruption.

Tundia NL, Kelton CML, Cavanaugh TM, Guo JJ, Hanseman DJ, Heaton PC. **The effect of electronic medical record system sophistication on preventive healthcare for women**. J Am Med Inform Assoc 2013;20(2):268-276.
Abstract: Objective To observe the effect of electronic medical record (EMR) system sophistication on preventive women's healthcare. Materials and Methods Providers in the National Ambulatory Medical Care Survey (NAMCS), 2007-8, were included if they had at least one visit by a woman at least 21 years old. Based on 16 questions from NAMCS, the level of a provider's EMR system sophistication was classified as non-existent, minimal, basic, or fully functional. A two-stage residual-inclusion method was used with ordered probit regression to model the level of EMR system sophistication, and outcome-specific Poisson regressions to predict the number of examinations or tests ordered or performed. Results Across the providers, 29.23%, 49.34%, 15.97%, and 5.46% had no, minimal, basic, and fully functional EMR systems, respectively. The breast examination rate was 20.27%, 34.96%, 37.21%, and 44.98% for providers without or with minimal, basic, and fully functional EMR systems, respectively. For breast examinations, pelvic examinations, Pap tests, chlamydia tests, cholesterol tests, mammograms, and bone mineral density (BMD) tests, an EMR system increased the number of these tests and examinations. Furthermore, the level of sophistication increased the number of breast examinations and Pap, chlamydia, cholesterol, and BMD tests. Discussion The use of advanced EMR systems in obstetrics and gynecology was limited. Given the positive results of this study, specialists in women's health should consider investing in more sophisticated systems. Conclusions The presence of an EMR system has a positive impact on preventive women's healthcare; the more functions that the system has, the greater the number of examinations and tests given or prescribed.

Vartak S, Crandall DK, Brokel JM, Wakefield DS, Ward MM. **Transformation of Emergency Department processes of care with EHR, CPOE, and ER event tracking systems**. Health Information Management Journal 2009;38(2):27-32.
Abstract: Mercy Medical Center, North Iowa implemented electronic health records (EHR), computerised provider order entry (CPOE) and event tracking systems in the emergency department (ED) as part of hospital-wide implementation of clinical information systems. This case study examines the changes in outcomes and processes in the ED following implementation. Although the system was designed to enhance efficiency, there was a significant increase in the mean length of stay (about 17 minutes, or 15%) in the ED after implementation. This surprising finding was examined in relationship to the multiple process-of-care changes in the ED.

Vest JR, Kern LM, Campion TR, Jr., Silver MD, Kaushal R. **Association between use of a health information exchange system and hospital admissions**. Appl Clin Inform 2014;5(1):219-231.
Abstract: OBJECTIVE: Relevant patient information is frequently difficult to obtain in emergency department (ED) visits. Improved provider access to previously inaccessible patient

information may improve the quality of care and reduce hospital admissions. Health information exchange (HIE) systems enable access to longitudinal, community-wide patient information at the point of care. However, the ability of HIE to avert admissions is not well demonstrated. We sought to determine if HIE system usage is correlated with a reduction in admissions via the ED.
METHODS: We identified 15,645 adults from New York State with an ED visit during a 6-month period, all of whom consented to have their information accessible in the HIE system, and were continuously enrolled in two area health plans. Using claims we determined if the ED encounter resulted in an admission. We used the HIE's system log files to determine usage during the encounter. We determined the association between HIE system use and the likelihood of admission to the hospital from the ED and potential cost savings.
RESULTS: The HIE system was accessed during 2.4% of encounters. The odds of an admission were 30% lower when the system was accessed after controlling for confounding (odds ratio = 0.70; 95%C I= 0.52, 0.95). The annual savings in the sample was $357,000.
CONCLUSION: These findings suggest that the use of an HIE system may reduce hospitalizations from the ED with resultant cost savings. This is an important outcome given the substantial financial investment in interventions designed to improve provider access to patient information in the US.

Vest JR, Kern LM, Silver MD, Kaushal R, investigators H. **The potential for community-based health information exchange systems to reduce hospital readmissions**. J Am Med Inform Assoc 2015;22(2):435-442.
Abstract: BACKGROUND: Hospital readmissions are common, costly, and offer opportunities for utilization reduction. Electronic health information exchange (HIE) systems may help prevent readmissions by improving access to clinical data by ambulatory providers after discharge from the hospital.
OBJECTIVE: We sought to determine the association between HIE system usage and 30-day same-cause hospital readmissions among patients who consented and participated in an operational community-wide HIE during a 6-month period in 2009-2010.
METHODS: We identified a retrospective cohort of hospital readmissions among adult patients in the Rochester, New York area. We analyzed claims files from two health plans that insure more than 60% of the area population. To be included in the dataset, patients needed to be continuously enrolled in the health plan with at least one encounter with a participating provider in the 6months following consent to be included in the HIE system. Each patient appeared in the dataset only once and each discharge could be followed for at least 30days.
RESULTS: We found that accessing patient information in the HIE system in the 30days after discharge was associated with a 57% lower adjusted odds of readmission (OR 0.43; 95% CI 0.27 to 0.70). The estimated annual savings in the sample from averted readmissions associated with HIE usage was $605000.
CONCLUSIONS: These findings indicate that usage of an electronic HIE system in the ambulatory setting within 30days after hospital discharge may effectively prevent hospital readmissions, thereby supporting the need for ongoing HIE efforts.

Vest JR, Miller TR. **The association between health information exchange and measures of patient satisfaction**. Appl Clin Inform 2011;2(4):447-459.
Abstract: OBJECTIVE: Health information exchange (HIE) is the interorganizational sharing of patient information and is one of many health information technology initiatives expected to transform the U.S. healthcare system. Two outcomes expected to be improved

by HIE are patient-provider communication and patient satisfaction . This analysis examined the relationship between the level of HIE engagement and these two factors in a sample of U.S. hospitals.
METHODS: Independent variables came from existing secondary sources and the dependent measures were from the Hospital Consumer Assessment of Healthcare Providers and Systems. The analysis included 3,278 hospitals. Using ordinary least squares regression, implemented HIE was positively associated with the percentage of patients reporting nurses communicated well and higher satisfaction. Due to the potential for selection bias, results were further explored using a propensity score analysis.
RESULTS: Hospitals that had adopted HIE, but not yet implemented saw no benefits. Hospitals' level of HIE was not associated with the percentage of patients reporting doctors communicated well. According to propensity score corrected estimates, implemented HIE was associated with the percentage of patients who reported nurses always communicated well and who would definitely recommend the hospital.
CONCLUSION: Few studies have examined the impact of HIE at the organizational level. This examination provides some evidence that hospitals engaging in HIE are associated with higher patient satisfaction.

Vest JR, Grinspan ZM, Kern LM, Campion TR, Jr., Kaushal R, Investigators H. **Using a health information exchange system for imaging information: patterns and predictors**. AMIA Annual Symposium Proceedings/AMIA Symposium 2013;2013:1402-1411.
Abstract: Health information exchange (HIE) systems may address the challenges that prevent easy access to patients' existing radiological information at the point of care. However, little is known about the factors associated with usage of HIE for radiology reports, nor about how reports are shared with an exchange network. We analyzed the system log files from a regional health information organization in upstate New York matched with insurance claims files using network analysis and regression modeling. The exchange network was dominated by a few key information sources. Outpatient users overall accessed 17 times more radiology reports than inpatient and ED users combined. Additionally, as the number of exchange partners increased per organization, the average number of reports exchanged by that organization also increased. Radiology reports were most likely to be accessed by physicians and other clinical users. These findings have implications for those operating and fostering exchange activity.

Viitanen J, Kuusisto A, Nykanen P. **Usability of electronic nursing record systems: Definition and results from an evaluation study in Finland**. Stud Health Technol Inform 2011;164:333-338.
Abstract: Information technologies (IT) are widely used in healthcare, however, little is known about the usability of nursing information systems. This article reports an evaluation study that aimed at researching the usability of four electronic nursing record (ENR) systems and thereby providing guidelines for further IT development. For the purposes of the study the concept of usability was defined to cover the following aspects: nurse-computer interaction in working context, information exchange, and collaboration between healthcare professionals. The study utilized two usability research methods, contextual inquiry and expert review, and was conducted with 18 nurses in Finland. Study results showed that the ENR systems share several usability problems in common, most of them relating to the efficiency of use, intuitiveness, and poor fit for multi-professional needs. Nurses had mainly negative experiences on documenting practices with ENRs: documentation requires a lot of resources, patient information is hard to find, and procedures do not meet the contextual needs. These findings suggest usability problems having significant effects on nurses' documentation practices and nursing work. © 2011 ITCH 2011 Steering Committee and IOS Press.

Wahl PM, Rassen JA, Rosenman MB, Mines D, Glynn RJ, Schneeweiss S. **Information gained by linking administrative claims to structured electronic health record data in a statin comparative effectiveness study**. Pharmacoepidemiol Drug Saf 2013;22:30.
Abstract: Background: It is hoped that unmeasured confounding in observational comparative effectiveness research (CER) may be addressed by linking patient claims to electronic health record (EHR) data. However, EHR data are themselves subject to missingness. Objectives: Assess the gain in information achieved by linking administrative claims to a regional health information exchange (HIE), for important clinical covariates in a population of statin initiators. Methods: We identified adults (> 18 years of age) with > 6 months health plan enrollment and no statin use during the6-month period prior to new statin use between July 2004 and May 2010 in the HealthCore Integrated Research Database. We then linked a subset residing in Indiana to a regional HIE and extracted demographic, clinical and laboratory parameters for key potential confounders available in the 6-month pre-index period. Proportions of patients with missing claims and EHR-based data were calculated. Results: About 22,300 linked patients had non-null structured or free text data available at any time pre- or post-index in the EHR. Of these, 51% were male, and 73% were 41-64 years of age. Fourty-four percent initiated therapy with simvastatin. 99%, 89%, and 90% of the linked cohort were missing outpatient claims laboratory values for glucose, triglycerides and LDL/HDL, respectively. Race was systematically unavailable in claims data. Virtually all patients (98%) were missing at least one of the EHR covariates of interest. Supplementing outpatient claims with EHR data from the 6 month pre-index period reduced the missingness to 13%, 63%, 81% and 82% for race, glucose, triglycerides and LDL/ HDL, respectively. Blood pressure was missing in 99% and body mass index in 98% of the linked cohort during the 6 month pre-index period. Conclusions: Linking claims to a regional HIE provided modest improvement in the availability of lab test results and yielded mostly complete race data. Most patients in a given study are likely to have at least one confounder missing, making it a challenge to simultaneously adjust for multiple confounders.

Warren J, Gu Y, Humphrey G. **Usage analysis of a shared care planning system**. AMIA Annual Symposium Proceedings/AMIA Symposium 2012;2012:950-959.
Abstract: We examined the content of electronically mediated communications in a trial of shared care planning (SCP) for long-term condition management. Software supports SCP by sharing patient records and care plans among members of the multidisciplinary care team (with patient access). Our analysis focuses on a three-month period with 73 enrolled patients, 149 provider-assigned tasks, 64 clinical notes and 48 care plans with 162 plan elements. Results show that content of notes entries is often related to task assignment and that nurses are the most active users. Directions for refinement of the SCP technology are indicated, including better integration of notes, tasks and care team notifications, as well as the central role of nurses for design use cases. Broader issues are raised about workforce roles and responsibilities for SCP, integrating patient-provider and provider-provider communications, and the centrality of care plans as the key entity in mediation of the care team.

Wilcox AB, Shen S, Dorr DA, Hripcsak G, Heermann L, Narus SP. **Improving access to longitudinal patient health information within an emergency department**. Appl Clin Inform 2012;3(3):290-300.
Abstract: We designed and implemented an electronic patient tracking system with improved user authentication and patient selection. We then measured access to clinical information from previous clinical encounters before and after implementation of the system. Clinicians accessed longitudinal information for 16% of patient encounters before, and 40% of patient encounters after the intervention, indicating such a system can improve clinician access to information. We also attempted to evaluate the impact of providing this access on inpatient admissions from the emergency department, by comparing

the odds of inpatient admission from an emergency department before and after the improved access was made available. Patients were 24% less likely to be admitted after the implementation of improved access. However, there were many potential confounders, based on the inherent pre-post design of the evaluation. Our experience has strong implications for current health information exchange initiatives.

Zlabek JA, Wickus JW, Mathiason MA. **Early cost and safety benefits of an inpatient electronic health record**. J Am Med Inform Assoc 2011;18(2):169-172.

Abstract: There is controversy over the impact of electronic health record (EHR) systems on cost of care and safety. The authors studied the effects of an inpatient EHR system with computerized provider order entry on selected measures of cost of care and safety. Laboratory tests per week per hospitalization decreased from 13.9 to 11.4 (18%; $p < 0.001$). Radiology examinations per hospitalization decreased from 2.06 to 1.93 (6.3%; $p < 0.009$). Monthly transcription costs declined from $74,596 to $18,938 (74.6%; $p < 0.001$). Reams of copy paper ordered per month decreased from 1668 to 1224 (26.6%; $p < 0.001$). Medication errors per 1000 hospital days decreased from 17.9 to 15.4 (14.0%; $p < 0.030$), while near misses per 1000 hospital days increased from 9.0 to 12.5 (38.9%; $p < 0.037$), and the percentage of medication events that were medication errors decreased from 66.5% to 55.2% ($p < 0.007$). In this manuscript, we demonstrate that the implementation of an inpatient EHR with computerized provider order entry can result in rapid improvement in measures of cost of care and safety

Henvisninger og tester

Ikke-randomiserte studier og observasjonelle design

Adelson KB, Qiu YC, Evangelista M, Spencer-Cisek P, Whipple C, Holcombe RF. **Implementation of electronic chemotherapy ordering: An opportunity to improve evidence-based oncology care**. J Oncol Pract 2014;10(2):e113-e119.

Abstract: Purpose: The degree to which electronic health records (EHRs) enhance the quality of patient care depends on use of the system to monitor and improve practice. In planning the transition to Epic's Beacon electronic chemotherapy ordering platform, we saw an opportunity to measure our performance and increase evidence-based practice. Methods: Advanced planning began 2 years before implementation and included formation of a chemotherapy council charged with reviewing references and approving each chemotherapy protocol; a readiness assessment; design of electronic flow-sheet adherent with Oncology Nursing Society guidelines. To monitor use of evidence-based treatments, we created a novel quality metric: the rate of evidence-based adherence (REBA). Results: A full infusion schedule was maintained through implementation, with a transient 1-month increase in wait time. Our overallREBAof 0.86 significantly exceeded our prespecified goal of 0.80 ($P = .001$). REBA varied from 0.50 to 0.95 between disease groups. Antiemetic use increased by 20% after Beacon implementation. Provider satisfaction at 8 months ranged from 76% to 80%. Conclusion: The transition to electronic chemotherapy ordering offers an institution the chance to develop evidence-based oncology practice, standardize supportive care, and enhance patient safety. The key elements that made our transition so successful were (1) extensive involvement of oncology leadership, (2) use of a chemotherapy council to enforce evidence-based practice, (3) ongoing collaboration between clinical

operations and information technology. Finally, the REBA is a powerful tool to monitor adherence to evidence-based chemotherapy prescribing. Copyright © 2013 by American Society of Clinical Oncology.

Agarwal R, Bleshman MH, Langlotz CP. **Comparison of two methods to transmit clinical history information from referring providers to radiologists**. Journal of the American College of Radiology 2009;6(11):795-799.
Abstract: PURPOSE: At many institutions, clerical personnel manually enter clinical histories into radiology information systems during the process of scheduling examinations. For outpatients, radiologists use this information as their primary source of clinical histories. The purpose of this study was to determine the discrepancy rate between these manually recorded clinical histories and paper request slips, thereby assessing the accuracy of the clinical information used by radiologists at the time of interpretation.
MATERIALS AND METHODS: A total of 129 imaging request slips for CT scans were randomly selected from 7 days in February and March 2007. The clinical history on each request slip was compared with the clinical history manually entered into the radiology information system. Discrepancies between paper request slips and the electronic information available to radiologists were placed into 4 categories: 1) no discrepancy, 2) electronic or paper history incomplete, 3) disagreement between electronic and paper information, and 4) other. Incomplete or discrepant histories were further subcategorized on the basis of whether they were clinically significant.
RESULTS: Thirty-eight percent of studies (49 of 129) had no discrepancies between the paper request slips and the manually entered electronic information. The remaining 62% of studies (80 of 129) had incomplete or discrepant clinical histories. Forty-nine percent of studies (63 of 129) had incomplete electronic or paper information. Greater than half of those incomplete histories (36 of 63) were clinically significant. Ten percent of cases (13 of 129) showed frank disagreements between paper and electronic information. Sixty-nine percent of these (9 of 13) were clinically significant. Three percent of studies (4 of 129) showed other discrepancies whose clinical significance could not be categorized.
CONCLUSION: The manual entry of clinical information introduces a high rate of discrepancies, most of which are clinically significant. These discrepancies highlight the need for better communication between referring providers and radiologists.

Li L, Georgiou A, Vecellio E, Eigenstetter A, Toouli G, Wilson R, et al. **What is the effect of electronic pathology ordering on test re-ordering patterns for paediatric patients?** Stud Health Technol Inform 2014;204:74-79.
Abstract: Electronic ordering systems have the potential to enhance the efficient utilisation of pathology services. The aim of this study was to assess the effect of electronic pathology ordering on repeat test ordering for paediatric patients (ages 0 to 18 years) who were in intensive care units (ICUs) and non-ICU wards. The dataset described 85,728 pathology tests ordered for 5,073 children before and after the implementation of electronic ordering. This study showed that, for children in ICUs, the repeat test order rate was significantly lower for electronic orders than for paper-based orders. Similarly, the rate of repeat tests ordered within short intervals (up to 23-hours), for children older than one-year in non-ICU wards, was lower for electronic ordering than for paper ordering. The proportion of repeat tests occurring within one-hour of the previous test was consistently lower for tests ordered using electronic ordering than it was for tests ordered using the paper based system for patients older than one-year in all wards and for patients under one-year in ICUs. These results suggest that features of the electronic system, including alerts about previously ordered tests and the availability of information about previous orders, can help clinicians to identify and reduce unnecessary repeat tests.

Schneider E, Franz W, Spitznagel R, Bascom DA, Obuchowski NA. **Effect of computerized**

physician order entry on radiologic examination order indication quality. Arch Intern Med 2011;171(11):1036-1038.

Abstract:

Weiner M, El Hoyek G, Wang L, Dexter PR, Zerr AD, Perkins AJ, et al. **A web-based generalist-specialist system to improve scheduling of outpatient specialty consultations in an academic center**. J Gen Intern Med 2009;24(6):710-715.

Abstract: BACKGROUND: Failed referrals for specialty care are common and often represent medical errors. Technological structures and processes account for many failures. Scheduling appointments for subspecialty evaluation is a first step in outpatient referral and consultation.

OBJECTIVE: We determined whether moving from paper-based referrals to a Web-based system with automated tracking features was associated with greater scheduling of appointments among referred patients.

DESIGN: Staggered implementation of a quality-improvement project, with comparison ofintervention and control groups.

PARTICIPANTS: Patients 21 or more years of age referred from any of 11 primary-care clinics to any of 25 specialty clinics.

INTERVENTIONS: Faxed referrals were replaced by a Web-based application shared by generalists and specialists, with enhanced communications and automated notification to the specialty office.

MEASUREMENTS: We compared scheduling before and after implementation and time from referral to appointment. A logistic regression analysis adjusted for demographics.

MAIN RESULTS: Among 40,487 referrals, 54% led to scheduled specialty visits before intervention, compared to 83% with intervention. The median time to appointment was 168 days without intervention and 78 days with intervention. Scheduling increased more when duplicate referrals were not generated (54% for single orders, 24% for multiple orders). After adjustment, referrals with the intervention were more than twice as likely to have scheduled visits.

CONCLUSIONS: With a new Web-based referrals system, referrals were more than twice as likely to lead to a scheduled visit. This system improves access to specialty medical services.

Were MC, Abernathy G, Hui SL, Kempf C, Weiner M. **Using computerized provider order entry and clinical decision support to improve referring physicians' implementation of consultants' medical recommendations**. J Am Med Inform Assoc 2009;16(2):196-202.

Abstract: OBJECTIVES: Only half of consultants' medical recommendations are implemented. We created a tool that lets referring providers review and implement electronic recommendations made by consultants, with the hypothesis that facilitation with our tool could improve implementation.

MEASUREMENTS: The tool was piloted among geriatrics consultants and hospitalists. Pre-post evaluation was done with control (before pilot; N=20) and intervention (after pilot; N=20) patients. Consultants wrote notes containing recommendations for all study patients, and entered electronic recommendations only for intervention patients. We analyzed all recommendations and surveyed hospitalists.

RESULTS: A total of 249 recommendations were made for intervention patients versus 192 for controls ($p<0.05$). Of all recommendations about intervention patients, 78% were implemented, compared to 59% for controls ($p=0.01$). Of the intervention recommendations, 77% were entered electronically using our tool; of these, 86% were implemented. All 24 survey respondents indicated that the system improved quality, saved time, and should be expanded.

CONCLUSION: Consultant recommendations were implemented 30% more often when

there was electronic facilitation of recommendations.

Forskrivning og medikamenthåndtering

Randomiserte studier

Agarwal D, Chandra S, Kolb L, Boggust A, Smith V, Sadosty AT, et al. **A study to evaluate emergency provider efficiency and cognitive load using different methods of computerized physician medication order entry**. Acad Emerg Med2013. p. S294-s295.
Abstract: Background: In the process of clinical training, emergency medicine providers (EMP) are taught heuristics based on patients' chief complaints. This approach could potentially be leveraged in designing computerized physician order entry (CPOE) and medication order placement. We hypothesized that medication orders based on chief complaint would decrease the EMP's cognitive load and increase efficiency. Objectives: To compare EMP time to task completion and cognitive load when medication orders are placed using chief complaint based versus pharmacological classification versus free text search grouping. Methods: We conducted a randomized cross-over trial in an academic tertiary care emergency department simulating the clinical work environment at a work station. Thirty clinicians were randomized to medication order entry using one of the three modes: chief complaint based (e.g. chest pain, headache), pharmacological category (e.g. adrenergic agents, antihistamine), and free text search. Nine simulated patient scenarios were developed to test the hypothesis. The main outcomes were time to task completion and provider cognitive load, as measured by the validated NASA-task load index. We compared time to task completion and provider cognitive load between modes of medication order entry using the Wilcoxon rank-sum test. Results: Overall, 30 clinicians (13 residents, 12 consultants, and 5 advanced practice providers) participated in the study. Median time to task completion was lowest using chief complaint based categories (55 seconds, IQR: 45-67) compared to pharmacological categories (139 seconds, IQR: 107-162) and free-text search (168 seconds, IQR: 126-197) (p >0.001; figure). Median NASA-task load index was also significantly lower with the chief complaint based categories (6.1, IQR: 3.5-9.5) compared to free text search (14.4, IQR: 11.7-16.9) and pharmacologic categories (13.6, (IQR: 10.4-15.6) (p >0.0001; figure). Conclusion: CPOE using chief complaint based grouping is substantially more efficient and requires less cognitive effort than medication ordering using pharmacologic groupings or free text search. Chief complaint based medication grouping for CPOE in emergency medicine has potential to increase clinical efficiency and potentially limit increased length of stay associated with implementation of an electronic health record. (Table Presented).

Gurwitz JH, Field TS, Rochon P, Judge J, Harrold LR, Bell CM, et al. **Effect of computerized provider order entry with clinical decision support on adverse drug events in the long-term care setting**. J Am Geriatr Soc2008. p. 2225-2233.
Abstract: OBJECTIVES: To evaluate the efficacy of computerized provider order entry with clinical decision support for preventing adverse drug events in long-term care. DESIGN: Cluster-randomized controlled trial. SETTING: Two large long-term care facilities. PATIENTS: One thousand one hundred eighteen long-term care residents of 29 resident care units. INTERVENTION: The 29 resident care units, each with computerized provider order entry, were randomized to having a clinical decision support system (intervention units) or not (control units). MEASUREMENTS: The number of adverse drug events, severity of

events, and whether the events were preventable. RESULTS: Within intervention units, 411 adverse drug events occurred over 3,803 resident-months of observation time; 152 (37.0%) were deemed preventable. Within control units, there were 340 adverse drug events over 3,257 resident-months of observation time; 126 (37.1%) were characterized as preventable. There were 10.8 adverse drug events per 100 resident-months and 4.0 preventable events per 100 resident-months on intervention units. There were 10.4 adverse drug events per 100 resident-months and 3.9 preventable events per 100 resident-months on control units. Comparing intervention and control units, the adjusted rate ratios were 1.06 (95% confidence interval (CI)=0.92-1.23) for all adverse drug events and 1.02 (95% CI=0.81-1.30) for preventable adverse drug events. CONCLUSION: Computerized provider order entry with decision support did not reduce the adverse drug event rate or preventable adverse drug event rate in the long-term care setting. Alert burden, limited scope of the alerts, and a need to more fully integrate clinical and laboratory information may have affected efficacy.

Hug BL, Witkowski DJ, Sox CM, Keohane CA, Seger DL, Yoon C, et al. **Adverse drug event rates in six community hospitals and the potential impact of computerized physician order entry for prevention**. J Gen Intern Med 2010;25(1):31-38.
Abstract: CONTEXT: Medications represent a major cause of harm and are costly for hospitalized patients, but more is known about these issues in large academic hospitals than in smaller hospitals.
OBJECTIVE: To assess the incidence of adverse drug events (ADEs) in six community hospitals.
DESIGN: Multicenter, retrospective cohort study.
SETTING: Six Massachusetts community hospitals with 100 to 300 beds.
PATIENTS: From 109,641 adult patients hospitalized from January 2005 through August 2006, a random sample of 1,200 patients was drawn, 200 per site.
MAIN OUTCOME MEASURES: ADEs and preventable ADEs.
METHODS: Presence of an ADE was evaluated using an adaptation of a trigger instrument developed by the Institute for Health Care Improvement. Independent reviewers classified events by preventability, severity, and potential for preventability by computerized physician order entry (CPOE).
RESULTS: A total of 180 ADEs occurred in 141 patients (rate, 15.0/100 admissions). Overall, 75% were preventable. ADEs were rated as serious in 49.4% and life threatening in 11.7%. Patients with ADEs were older (mean age, 74.6 years, $p < 0.001$), more often female (60.3%, $p = 0.61$), and more often Caucasian (96.5%, $p < 0.001$) than patients without ADEs. Of the preventable ADEs, 81.5% were judged potentially preventable by CPOE.
CONCLUSIONS: The incidence of ADEs in these community hospital admissions was high, and most ADEs were preventable, mostly through CPOE. These data suggest that CPOE may be beneficial in this setting.

Strom BL, Schinnar R, Aberra F, Bilker W, Hennessy S, Leonard CE, et al. **Unintended effects of a computerized physician order entry nearly hard-stop alert to prevent a drug interaction: a randomized controlled trial**. Arch Intern Med2010. p. 1578-1583.
Abstract: BACKGROUND: The effectiveness of computerized physician order entry (CPOE) systems has been modest, largely because clinicians frequently override electronic alerts.
METHODS: To evaluate the effectiveness of a nearly "hard stop" CPOE prescribing alert intended to reduce concomitant orders for warfarin and trimethoprim-sulfamethoxazole, a randomized clinical trial was conducted at 2 academic medical centers in Philadelphia, Pennsylvania. A total of 1981 clinicians were assigned to either an intervention group receiving a nearly hard stop alert or a control group receiving the standard practice. The study duration was August 9, 2006, through February 13, 2007. RESULTS: The proportion

of desired responses (ie, not reordering the alert-triggering drug within 10 minutes of firing) was 57.2% (111 of 194 hard stop alerts) in the intervention group and 13.5% (20 of 148) in the control group (adjusted odds ratio, 0.12; 95% confidence interval, 0.045-0.33). However, the study was terminated early because of 4 unintended consequences identified among patients in the intervention group: a delay of treatment with trimethoprim-sulfamethoxazole in 2 patients and a delay of treatment with warfarin in another 2 patients. CONCLUSIONS: An electronic hard stop alert as part of an inpatient CPOE system seemed to be extremely effective in changing prescribing. However, this intervention precipitated clinically important treatment delays in 4 patients who needed immediate drug therapy. These results illustrate the importance of formal evaluation and monitoring for unintended consequences of programmatic interventions intended to improve prescribing habits. TRIAL REGISTRATION: clinicaltrials.gov Identifier: NCT00870298.

Ikke-randomiserte studier og observasjonelle design

Computerized provider order entry for medications: adult inpatients. Lansdale, PA: HAYES, Inc 2009.

Adam TJ, Waitman R, Jones I, Aronsky D. **The effect of computerized provider order entry (CPOE) on ordering patterns for chest pain patients in the emergency department**. AMIA Annual Symposium Proceedings/AMIA Symposium 2011;2011:38-47.
Abstract: This study addressed the effect of CPOE implementation on chest pain ordering patterns for patients in the emergency department. Retrospective order data was collected to assess the implementation. 300 randomly selected, time matched patients with a chief complaint of chest pain were selected in a before/after study. Patient demographics, treatment and disposition data were collected on clinical orders. Order volume, completeness and completion times were assessed before and after implementation. Overall order volume increased significantly from 11.6 pre-CPOE to 19.9 post-implementation (p<.01). Order documentation deficiencies were noted pre-implementation with 35.6% containing all order elements. Order completion times were unchanged; however, laboratory completion times increased for admitted patients post-implementation. Order volume increased after CPOE implementation, likely due to improved ED-based admission order capture for admitted patients. Order completeness improved significantly including standing order documentation. Overall, CPOE implementation is associated with improved clinical documentation with limited effect on clinical testing turn-around times.

Adams ES, Longhurst CA, Pageler N, Widen E, Franzon D, Cornfield DN. **Computerized physician order entry with decision support decreases blood transfusions in children**. Pediatrics 2011;127(5):e1112-1119.
Abstract: OBJECTIVE: Timely provision of evidence-based recommendations through computerized physician order entry with clinical decision support may improve use of red blood cell transfusions (RBCTs).
METHODS: We performed a cohort study with historical controls including inpatients admitted between February 1, 2008, and January 31, 2010. A clinical decision-support alert for RBCTs was constructed by using current evidence. RBCT orders resulted in assessment of the patient's medical record with prescriber notification if parameters were not within recommended ranges. Primary end points included the average pretransfusion hemoglobin level and the rate of RBCTs per patient-day.
RESULTS: In total, 3293 control discharges and 3492 study discharges were evaluated. The mean (SD) control pretransfusion hemoglobin level in the PICU was 9.83 (2.63) g/dL (95% confidence interval [CI]: 9.65-10.01) compared with the study value of 8.75 (2.05) g/dL (95% CI: 8.59-8.90) (P < .0001). The wards' control value was 7.56 (0.93) g/dL (95% CI: 7.47-7.65), the study value was 7.14 (1.01) g/dL (95% CI: 6.99-7.28) (P < .0001). The control PICU

rate of RBCTs per patient-day was 0.20 (0.11) (95% CI: 0.13-0.27), the study rate was 0.14 (0.04) (95% CI: 0.11-0.17) (P = .12). The PICU's control rate was 0.033 (0.01) (95% CI: 0.02-0.04), and the study rate was 0.017 (0.007) (95% CI: 0.01-0.02) (P < .0001). There was no difference in mortality rates across all cohorts.
CONCLUSIONS: Implementation of clinical decision-support alerts was associated with a decrease in RBCTs, which suggests improved adoption of evidence-based recommendations. This strategy might be widely applied to promote timely adoption of scientific evidence.

Ahmadian L, Khajouei R. **Impact of computerized order sets on practitioner performance**. Stud Health Technol Inform 2012;180:1129-1131.
Abstract: Order sets have the potential to provide evidence at the point of care and improve healthcare practice. In this study we reviewed the literature to assess the effect of computerized order sets on practitioner performance. Our search in PubMed and Science direct identified 442 studies of which 16 met our inclusion criteria. In 15 studies order sets contributed to the improvement of at least one performance outcome. The effect of order sets was evaluated on 34 performance outcomes, of which 19 were improved and the rest remained unchanged. The results provide evidence that the use of order sets can improve health care practice.

Al-Dorzi HM, Tamim HM, Cherfan A, Hassan MA, Taher S, Arabi YM. **Impact of computerized physician order entry (CPOE) system on the outcome of critically ill adult patients: a before-after study**. BMC Med Inform Decis Mak 2011;11:71.
Abstract: BACKGROUND: Computerized physician order entry (CPOE) systems are recommended to improve patient safety and outcomes. However, their effectiveness has been questioned. Our objective was to evaluate the impact of CPOE implementation on the outcome of critically ill patients.
METHODS: This was an observational before-after study carried out in a 21-bed medical and surgical intensive care unit (ICU) of a tertiary care center. It included all patients admitted to the ICU in the 24 months pre- and 12 months post-CPOE (Misys) implementation. Data were extracted from a prospectively collected ICU database and included: demographics, Acute Physiology and Chronic Health Evaluation (APACHE) II score, admission diagnosis and comorbid conditions. Outcomes compared in different pre- and post-CPOE periods included: ICU and hospital mortality, duration of mechanical ventilation, and ICU and hospital length of stay. These outcomes were also compared in selected high risk subgroups of patients (age 12-17 years, traumatic brain injury, admission diagnosis of sepsis and admission APACHE II > 23). Multivariate analysis was used to adjust for imbalances in baseline characteristics and selected clinically relevant variables.
RESULTS: There were 1638 and 898 patients admitted to the ICU in the specified pre- and post-CPOE periods, respectively (age = 52 +/- 22 vs. 52 +/- 21 years, p = 0.74; APACHE II = 24 +/- 9 vs. 24 +/- 10, p = 0.83). During these periods, there were no differences in ICU (adjusted odds ratio (aOR) 0.98, 95% confidence interval [CI] 0.7-1.3) and in hospital mortality (aOR 1.00, 95% CI 0.8-1.3). CPOE implementation was associated with similar duration of mechanical ventilation and of stay in the ICU and hospital. There was no increased mortality or stay in the high risk subgroups after CPOE implementation.
CONCLUSIONS: The implementation of CPOE in an adult medical surgical ICU resulted in no improvement in patient outcomes in the immediate phase and up to 12 months after implementation.

Ali J, Barrow L, Vuylsteke A. **The impact of computerised physician order entry on prescribing practices in a cardiothoracic intensive care unit**. Anaesthesia 2010;65(2):119-123.
Abstract: This prospective, time series, cross-sectional study was designed to compare the

quality of handwritten vs computerised prescriptions in a tertiary 25-bedded cardiothoracic intensive care unit. A total of 14,721 prescriptions for 613 patients were analysed over three periods of investigation: 7 months before; and 5 and 12 months after implementation of a clinical information system with computerised physician order entry capability. Errors in prescribing were common. Only (53%) of handwritten charts analysed had all immediate administration drugs prescribed correctly. Errors included omission of route 81 (8.0%), date of prescription 78 (7.7%), and time to be given 255 (25.2%), and 119 (11.7%) had no dose or an incorrect dose prescribed. All errors of completeness were abolished following implementation. The computerised system led to a significant improvement in prescribing safety, in a clinical area previously highlighted as having a high rate of adverse drug errors. Legibility, completeness and traceability are no longer possible sources of medication errors.

Armada ER, Villamanan E, Lopez-de-Sa E, Rosillo S, Rey-Blas JR, Testillano ML, et al. **Computerized physician order entry in the cardiac intensive care unit: effects on prescription errors and workflow conditions**. J Crit Care 2014;29(2):188-193.
Abstract: PURPOSES: To evaluate the effects of a computerized physician order entry (CPOE) system in the cardiac intensive care unit by detecting prescription errors (PEs) and also to assess the impact on working conditions.
METHODS: A longitudinal, prospective, before-after study was conducted during the periods before and after the implementation of the CPOE system. Clinical pharmacists were responsible for the registration, description and classification of PEs, and their causes and severity, according to an international taxonomy. Professionals were also surveyed for their opinion, concerns, and level of satisfaction.
RESULTS: A total of 470 treatment orders containing 5729 prescriptions were evaluated. The CPOE resulted in a marked reduction in the number of PEs: error rate was 44.8% (819 errors among 1829 prescriptions) with handwritten orders and 0.8% (16 among 2094 prescriptions) at the final electronic phase ($P < .001$). Lapses were the main cause of error in both prescription methods. Most errors did not reach the patients. Errors related with the computerized system were scarce. Most users were satisfied with many aspects of this technology, although a higher workload was reported.
CONCLUSIONS: Computerized physician order entry in the cardiac intensive care unit proved to be a safe and effective strategy in reducing PEs and was globally well received by professionals.

Asaro PV, Boxerman SB. **Effects of computerized provider order entry and nursing documentation on workflow**. Acad Emerg Med 2008;15(10):908-915.
Abstract: Objectives: The objective was to measure the effects of the implementation of computerized provider order entry (CPOE) and electronic nursing documentation on provider workflow in the emergency department (ED). Methods: The authors performed a before-and-after time-motion study of the activities of physicians and nurses. The percentages of time spent in task categories were calculated by provider session and averaged across provider sessions. Results: There was a shift in physician time from working with paper alone, 13.1% to 9.6% ($p = 0.05$), to working with paper while using a computer, 1.6% to 4.3% ($p = 0.02$), and an increase in time spent working on computer and/or paper from 30.0% to 38.9% ($p = 0.02$). For nurses, the increase in time spent on computer from 9.5% to 25.7% ($p < 0.01$) was offset by a decrease in time spent working with paper from 16.5% to 1.8% ($p < 0.01$). Direct care decreased minimally for nurses from 56.9% to 55.3% ($p = 0.69$), but from 36.8% to 29.1% ($p = 0.07$) for physicians, approaching statistical significance. Care planning decreased for nurses from 9.4% to 6.4% ($p = 0.04$) and from 21.7% to 19.5% ($p = 0.60$) for physicians. Conclusions: The net effects of an implementation on provider workflow depend not only on changes in tasks directly related to the provider-computer interface, but also on changes in underlying patient care processes and information

flows. The authors observed an unanticipated shift in physician time from interacting with nurses and patients toward retrieving information from the electronic patient record. Implementers should carefully consider how implementations will affect information flow and then expect the unexpected. © 2008 by the Society for Academic Emergency Medicine.

Bonnabry P, Despont-Gros C, Grauser D, Casez P, Despond M, Pugin D, et al. **A risk analysis method to evaluate the impact of a computerized provider order entry system on patient safety**. J Am Med Inform Assoc 2008;15(4):453-460.
Abstract: OBJECTIVES: Quantitative evaluation of safety after the implementation of a computerized provider order entry (CPOE) system, stratification of residual risks to drive future developments.
DESIGN: Comparative risk analysis of the drug prescription process before and after the implementation of CPOE system, according to the Failure Modes, Effects and Criticality Analysis (FMECA) method.
MEASUREMENTS: The failure modes were defined and their criticality indices calculated on the basis of the likelihood of occurrence, potential severity for patients, and detection probability. Criticality indices of handwritten and electronic prescriptions were compared, the acceptability of residual risks was discussed. Further developments were proposed and their potential impact on the safety was estimated.
RESULTS: The sum of criticality indices of 27 identified failure modes was 3813 for the handwritten prescription, 2930 (-23%) for CPOE system, and 1658 (-57%) with 14 enhancements. The major safety improvements were observed for errors due to ambiguous, incomplete or illegible orders (-245 points), wrong dose determination (-217) and interactions (-196). Implementation of targeted pop-ups to remind treatment adaptation (-189), vital signs (-140), and automatic edition of documents needed for the dispensation (-126) were the most promising proposed improvements.
CONCLUSION: The impact of a CPOE system on patient safety strongly depends on the implemented functions and their ergonomics. The use of risk analysis helps to quantitatively evaluate the relationship between a system and patient safety and to build a strategy for continuous quality improvement, by selecting the most appropriate improvements to the system.

Cartmill RS, Walker JM, Blosky MA, Brown RL, Djurkovic S, Dunham DB, et al. **Impact of electronic order management on the timeliness of antibiotic administration in critical care patients**. Int J Med Inform 2012;81(11):782-791.
Abstract: OBJECTIVE: To examine the effect of implementing electronic order management on the timely administration of antibiotics to critical-care patients.
METHODS: We used a prospective pre-post design, collecting data on first-dose IV antibiotic orders before and after the implementation of an integrated electronic medication-management system, which included computerized provider order entry (CPOE), pharmacy order processing and an electronic medication administration record (eMAR). The research was performed in a 24-bed adult medical/surgical ICU in a large, rural, tertiary medical center. Data on the time of ordering, pharmacy processing and administration were prospectively collected and time intervals for each stage and the overall process were calculated.
RESULTS: The overall turnaround time from ordering to administration significantly decreased from a median of 100 min before order management implementation to a median of 64 min after implementation. The first part of the medication use process, i.e., from order entry to pharmacy processing, improved significantly whereas no change was observed in the phase from pharmacy processing to medication administration.
DISCUSSION: The implementation of an electronic order-management system improved the timeliness of antibiotic administration to critical-care patients. Additional system

changes are required to further decrease the turnaround time.

Choo J, Johnston L, Manias E. **Effectiveness of an electronic inpatient medication record in reducing medication errors in Singapore**. Nurs Health Sci 2014;16(2):245-254.
Abstract: This study examined the effectiveness of an inpatient electronic medication record system in reducing medication errors in Singaporean hospitals. This pre- and post-intervention study involving a control group was undertaken in two Singaporean acute care hospitals. In one hospital the inpatient electronic medication record system was implemented while in another hospital the paper-based medication record system was used. The mean incidence difference in medication errors of 0.06 between pre-intervention (0.72 per 1000 patient days) and post-intervention (0.78 per 1000 patient days) for the two hospitals was not statistically significant (95%, CI: [0.26, 0.20]). The mean incidence differences in medication errors relating to prescription, dispensing, and administration were also not statistically different. Common system failures involved a lack of medication knowledge by health professionals and a lack of a systematic approach in identifying correct dosages. There was no difference in the incidence of medication errors following the introduction of the electronic medication record system. More work is needed on how this system can reduce medication error rates and improve medication safety.

Cunningham TR, Geller ES, Clarke SW. **Impact of electronic prescribing in a hospital setting: a process-focused evaluation**. Int J Med Inform 2008;77(8):546-554.
Abstract: OBJECTIVE: To evaluate effects of a natural CPOE implementation in a hospital setting and inform the efficacy of using CPOE rather than traditional paper medication orders.
DESIGN: A multiple-baseline, quasi-experimental study of a naturally occurring CPOE intervention, with a non-equivalent control site.
MEASUREMENTS: Compliance with medication-ordering protocols and time to first dose of antibiotics.
RESULTS: Medication orders placed using CPOE were significantly more compliant than paper-based medication orders, and first doses of antibiotics were delivered significantly faster when ordered with CPOE than when placed using the standard paper-based system ($p<.01$).
CONCLUSION: Findings support the use of CPOE and justify the need for interventions to increase CPOE adoption and consistent use among physicians.

Devine EB, Hansen RN, Wilson-Norton JL, Lawless NM, Fisk AW, Blough DK, et al. **The impact of computerized provider order entry on medication errors in a multispecialty group practice**. J Am Med Inform Assoc 2010;17(1):78-84.
Abstract: OBJECTIVE: Computerized provider order entry (CPOE) has been shown to improve patient safety by reducing medication errors and subsequent adverse drug events (ADEs). Studies demonstrating these benefits have been conducted primarily in the inpatient setting, with fewer in the ambulatory setting. The objective was to evaluate the effect of a basic, ambulatory CPOE system on medication errors and associated ADEs.
DESIGN: This quasiexperimental, pretest-post-test study was conducted in a community-based, multispecialty health system not affiliated with an academic medical center. The intervention was a basic CPOE system with limited clinical decision support capabilities.
MEASUREMENT: Comparison of prescriptions written before (n=5016 handwritten) to after (n=5153 electronically prescribed) implementation of the CPOE system. The primary outcome was the occurrence of error(s); secondary outcomes were types and severity of errors.
RESULTS: Frequency of errors declined from 18.2% to 8.2%-a reduction in adjusted odds

of 70% (OR: 0.30; 95% CI 0.23 to 0.40). The largest reductions were seen in adjusted odds of errors of illegibility (97%), use of inappropriate abbreviations (94%) and missing information (85%). There was a 57% reduction in adjusted odds of errors that did not cause harm (potential ADEs) (OR 0.43; 95% CI 0.38 to 0.49). The reduction in the number of errors that caused harm (preventable ADEs) was not statistically significant, perhaps due to few errors in this category.
CONCLUSIONS: A basic CPOE system in a community setting was associated with a significant reduction in medication errors of most types and severity levels.

Devine EB, Hollingworth W, Hansen RN, Lawless NM, Wilson-Norton JL, Martin DP, et al. **Electronic prescribing at the point of care: a time-motion study in the primary care setting**. Health Serv Res 2010;45(1):152-171.
Abstract: OBJECTIVE: To evaluate the impact of an ambulatory computerized provider order entry (CPOE) system on the time efficiency of prescribers. Two primary aims were to compare prescribing time between (1) handwritten and electronic (e-) prescriptions and (2) e-prescriptions using differing hardware configurations.
DATA SOURCES/STUDY SETTING: Primary data on prescribers/staff were collected (2005-2007) at three primary care clinics in a community based, multispecialty health system.
STUDY DESIGN: This was a quasi-experimental, direct observation, time-motion study conducted in two phases. In phase 1 (n=69 subjects), each site used a unique combination of CPOE software/hardware (paper-based, desktops in prescriber offices or hallway workstations, or laptops). In phase 2 (n=77), all sites used CPOE software on desktops in examination rooms (at point of care).
DATA COLLECTION METHODS: Data were collected using TimerPro software on a Palm device.
PRINCIPAL FINDINGS: Average time to e-prescribe using CPOE in the examination room was 69 seconds/prescription-event (new/renewed combined)-25 seconds longer than to handwrite (99.5 percent confidence interval [CI] 12.38), and 24 seconds longer than to e-prescribe at offices/workstations (99.5 percent CI 8.39). Each calculates to 20 seconds longer per patient.
CONCLUSIONS: E-prescribing takes longer than handwriting. E-prescribing at the point of care takes longer than e-prescribing in offices/workstations. Improvements in safety and quality may be worth the investment of time.

Dickens DS, Sinsabaugh D. **Impact of computerized prescriber order entry on the incidence of adverse drug events in pediatric inpatients**. Pediatrics 2008;122(3):678; author reply 678-679.
Abstract:

Hall AB, Montero J, Cobian J, Regan T. **The effects of an electronic order set on vancomycin dosing in the ED**. Am J Emerg Med 2015;33(1):92-94.
Abstract: OBJECTIVE: The objective of the study was to assess the impact of a computer physician order entry (CPOE) electronic order set on appropriate vancomycin dosing in the emergency department (ED).
METHODS: We conducted a retrospective study examining ED dosing of vancomycin before and after the implementation of an electronic weight-based vancomycin order set. Preimplementation and postimplementation patient records were analyzed between the dates of June 1st and August 31st 2010 for the pre-CPOE group and January 1st to March 31st 2013 for the post-CPOE group.
STATISTICAL ANALYSIS: chi(2) analysis, Fisher exact test, and t tests were performed with a 2-sided P value <.05 denoting statistical significance, where appropriate.
RESULTS: A total of 597 patients were included in the study, with 220 in the pre-CPOE group and 377 in the post-CPOE group. The use of the electronic order set resulted in a

21.9% increase (P < .05) in appropriate dosing with 67.4% (254/377) of post-CPOE vancomycin doses considered appropriate vs 45.5% (100/220) in the pre-CPOE group. In critically ill patients, there was a 16.3% increase in appropriate dosing with 44.7% (38/85) in the post-CPOE group compared with 28.4% (19/67) in the pre-CPOE group.
CONCLUSION: The implementation of an electronic order set increased the percentage of ED patients receiving appropriate initial vancomycin doses. The impact of increasing compliance to vancomycin guidelines is in accordance with stewardship principles that promote optimization of antimicrobial dosing based on individual patient characteristics. More studies are needed to assess the relationship between appropriate vancomycin loading doses in the ED and therapeutic outcomes.

Househ M, Ahmad A, Alshaikh A, Alsuweed F. **Patient safety perspectives: the impact of CPOE on nursing workflow**. Stud Health Technol Inform 2013;183:367-371.
Abstract: The purpose of this review is to explore the impact of Computerized Physician Order Entry (CPOE) systems on patient safety from a nursing perspective. The paper discusses the importance of safety culture within nursing, nursing perceptions of CPOE, and the impact of CPOE on nursing workflow. The findings indicate that the implementation of CPOE negatively impacts nursing workflow when CPOE systems are inadequately designed. Future work is necessary to explore the impact of CPOE on nursing workflow and the direct impact on patient safety.

Jozefczyk KG, Kennedy WK, Lin MJ, Achatz J, Glass MD, Eidam WS, et al. **Computerized prescriber order entry and opportunities for medication errors: comparison to tradition paper-based order entry**. J Pharm Pract 2013;26(4):434-437.
Abstract: PURPOSE: Predefined error opportunity categories were used as a surrogate for medication errors to assess the impact of computerized prescriber order entry (CPOE) on the potential for error in the prescribing and order entry phases of the medication-use process.
METHODS: This study was performed in a neonatal intensive care unit at a 535-bed tertiary care center. Pre- and post-CPOE implementation incidence of error opportunity was compared by evaluating 500 orders before and after implementation using 18 predefined criteria.
RESULTS: A total of 14 913 opportunities for error (OE) existed in our sample of 1000 medication orders. The number of orders with zero OE improved from 42% (n = 209) to 98% (n = 480; P < .0001), in the pre- and postgroups, respectively. The odds ratio with 95% confidence interval was 0.058 (0.036-0.094) in favor of CPOE.
CONCLUSIONS: The implementation of CPOE was associated with a reduction in OEs in the prescribing phase or order entry phase of the medication-use process.

Kaushal R, Barron Y, Abramson EL. **The comparative effectiveness of 2 electronic prescribing systems**. Am J Manag Care 2011;17(SPEC. ISSUE):SP88-SP94.
Abstract: Objectives: The increasingly widespread adoption of electronic health records (EHRs) is substantially changing the American healthcare delivery system. Differences in the actual effectiveness of EHRs and their component applications, including electronic prescribing (e-prescribing), is not well understood. We compared the effects of 2 types of e-prescribing systems on medication safety as an example of how comparative effectiveness research (CER) can be applied to the study of healthcare delivery. Study Design and Methods: We previously conducted 2 non-randomized, prospective studies with pre-post controls comparing prescribing errors among: (1) providers who adopted a standalone e-prescribing system with robust technical and clinical decision support (CDS) and (2) providers who adopted an EHR with integrated e-prescribing with less robust available CDS and technical support. Both studies evaluated small groups of ambulatory care providers

in the same New York community using identical methodology including prescription and chart reviews. We undertook this comparative effectiveness study to directly compare prescribing error rates among the 2 groups of e-prescribing adopters. Results: The stand-alone system reduced error rates from 42.5 to 6.6 errors per 100 prescriptions (P <.001). The integrated system reduced error rates from 26.0 to 16.0 per 100 prescriptions (P = .07). After adjusting for baseline differences, stand-alone users had a 4-fold lower rate of errors at 1 year (P <.001). Conclusions: Despite improved work flow integration, the integrated e-prescribing application performed less well, likely due to differences in available CDS and technical resources. Results from this small study highlight the importance of CER that directly compares components of healthcare delivery.

Lee JY, Leblanc K, Fernandes OA, Huh JH, Wong GG, Hamandi B, et al. **Medication reconciliation during internal hospital transfer and impact of computerized prescriber order entry**. Ann Pharmacother 2010;44(12):1887-1895.
Abstract: BACKGROUND: Internal hospital transfer is a vulnerable time during which patients are at high risk of medication discrepancies that can result in clinically significant harm, medication errors, and adverse drug events.
OBJECTIVE: To identify, characterize, and assess the clinical impact of unintentional medication discrepancies during internal hospital transfer and to investigate the influence of computerized prescriber order entry (CPOE) on medication discrepancies.
METHODS: All patients transferred between 10 inpatient units at 2 tertiary care hospitals were prospectively assessed to identify discrepancies. Interfaces included transfers between (1) units that both used paper-based medication ordering systems; (2) units that both used CPOE-based systems; and (3) units that used both paper-based and CPOE-based systems (hybrid transfer). The primary endpoint was the number of patients with at least 1 unintentional medication discrepancy during internal hospital transfer. Discrepancies were identified through assessment and comparison of a best possible medication transfer list with the actual transfer orders. A multidisciplinary team of clinicians assessed the potential clinical impact and severity of unintentional discrepancies.
RESULTS: Overall, 190 patients were screened and 129 patients were included. Eighty patients (62.0%) had at least 1 unintentional medication discrepancy at the time of transfer, and the most common discrepancy was medication omission (55.6%). Factors that independently increased the risk of a patient experiencing at least 1 unintentional discrepancy included lack of best possible medication history, increasing number of home medications, and increasing number of transfer medications. Forty-seven patients (36.4%) had at least 1 unintentional discrepancy with the potential to cause discomfort and/or clinical deterioration. The risk of discrepancies was present regardless of the medication-ordering system (paper, CPOE, or hybrid).
CONCLUSIONS: Clinically significant medication discrepancies occur commonly during internal hospital transfer. A structured, collaborative, and clearly defined medication reconciliation process is needed to prevent internal transfer discrepancies and patient harm.

Leighton H, Kianfar H, Serynek S, Kerwin T. **Effect of an electronic ordering system on adherence to the American College of Cardiology/American Heart Association guidelines for cardiac monitoring**. Critical Pathways in Cardiology: A Journal of Evidence-Based Medicine 2013;12(1):6-8.
Abstract: INTRODUCTION: Telemetry monitoring is often overused in the inpatient setting. This has led to overcrowding of telemetry beds, increased wait times in the emergency department, and inefficient allocation of hospital resources. The American College of Cardiology/American Heart Association (ACC/AHA) guidelines exist to guide appropriate utilization of cardiac monitoring. We sought to investigate the effect of the institution of an electronic ordering system (EOS) on adherence to guideline-based telemetry use.

METHODS: Telemetry bed utilization was followed prospectively before and after institution of the EOS. Patient records were reviewed and assessed for indication for telemetry monitoring at admission and at 48 hours, as well as telemetry events. The online order form was based on the ACC/AHA guidelines for in-hospital cardiac monitoring. The EOS mandates physicians to check the specific indication for monitoring. Initial telemetry order expires after 48 hours, and if continued monitoring is necessary, it must be reordered.
RESULTS: One hundred ninety-six patients before EOS and 156 patients after institution of EOS were assessed. Before EOS, 65% of patients placed on telemetry met guidelines for monitoring. Institution of EOS resulted in a significant improvement in compliance to 81% ($P < 0.001$). However, at 48 hours, compliance dropped with EOS from 31% to 13% ($P < 0.001$). All dysrhythmias observed occurred in patients who met guidelines for monitoring. There were no clinically significant events in patients who did not meet guidelines for telemetry monitoring.
CONCLUSION: The institution of an EOS significantly improved compliance with ACC/AHA guidelines for cardiac monitoring at the time of admission. However, compliance worsened after the initial 48 hours, which may have been due to the ease of online reordering with our EOS. Clinically significant events were only observed in patients who met criteria for monitoring. EOS can be a useful tool to improve adherence to guideline-based utilization of hospital resources.

Leung AA, Keohane C, Amato M, Simon SR, Coffey M, Kaufman N, et al. **Impact of vendor computerized physician order entry in community hospitals**. J Gen Intern Med 2012;27(7):801-807.
Abstract: BACKGROUND: It is uncertain if computerized physician order entry (CPOE) systems are effective at reducing adverse drug event (ADE) rates in community hospitals, where mainly vendor-developed applications are used.
OBJECTIVE: To evaluate the impact of vendor CPOE systems on the frequency of ADEs.
DESIGN AND PATIENTS: Prospective before-and-after study conducted from January 2005 to September 2010 at five Massachusetts community hospitals. Participants were adults admitted during the study period. A total of 2,000 charts were reviewed for orders, medication lists, laboratory reports, admission histories, notes, discharge summaries, and flow sheets.
MAIN MEASURES: The primary outcome measure was the rate of preventable ADEs. Rates of potential ADEs and overall ADEs were secondary outcomes.
KEY RESULTS: The rate of preventable ADEs decreased following implementation (10.6/100 vs. 7.0/100 admissions; $p = 0.007$) with a similar effect observed at each site. However, the associated decrease in preventable ADEs was balanced against an increase in potential ADEs (44.4/100 vs. 57.5/100 admissions; $p < 0.001$). We observed a reduction of 34.0% for preventable ADEs, but an increase of 29.5% in potential ADEs following implementation. The overall rate of ADEs increased (14.6/100 vs. 18.7/100 admissions; $p = 0.03$), which was driven by non-preventable events (4.0/100 vs. 11.7/100 admissions; $p < 0.001$).
CONCLUSIONS: Adoption of vendor CPOE systems was associated with a decrease in the preventable ADE rate by a third, although the rates of potential ADEs and overall ADEs increased. Our findings support the use of vendor CPOE systems as a means to reduce drug-related injury and harm. The potential ADE rate could be reduced by making refinements to the vendor applications and their associated decision support.

Long AJ, Chang P. **The effect of using the health smart card vs. CPOE reminder system on the prescribing practices of non-obstetric physicians during outpatient visits for pregnant women in Taiwan**. Int J Med Inform 2012;81(9):605-611.
Abstract: INTRODUCTION: There is an evidence that pregnant women have been prescribed a significant number of improper medications that could lead to potential damage for a developing fetus due to discontinuity of care. The safety of pregnant women raises

public concern and there is a need to identify ways to prevent potential adverse events to the pregnant woman. This study used a health smart card with a clinical reminder system to keep continuous records of general outpatient visits of pregnant women to protect them from potential adverse events caused by improper prescription.
METHOD: The health smart card, issued to all 23 million citizens in Taiwan, was used to work with a Computerized Physician Order Entry (CPOE) implemented at a 700-bed teaching medical center in Taipei to provide the outpatient information of pregnant women. FDA pregnancy risk classification was used to categorize the risk of pregnant women. The log file, combined with the physicians' and patients' profiles, were statistically examined using the Mantel-Haenszel technique to evaluate the impact of system in changing physician's prescription behavior.
RESULTS: A total of 441 patients ranged in age from 15 to 50 years with 1114 prescriptions involved in FDA pregnancy risk classification C, D, and X during the study period. 144 reminders (13.1%) were accepted by physicians for further assessment and 100 (69.4%) of them were modified. Non-obstetric physicians in non-emergency setting were more intended to accept reminders (27.8%, 4.9 folds than obstetricians). Reminders triggered on patients in second trimester (15.5%) were accepted by all physicians more than third trimester (OR 1.52, $p<0.05$).
CONCLUSION: A health smart card armed with CPOE reminder system and well-defined criteria had the potential to decrease harmful medication prescribed to pregnant patients. The results show better conformance for non-obstetric physicians (26%) and when physicians accepted the alerts they are more likely to went back and review their orders (69%). In sum, reminder criteria of FDA pregnancy risk classification C for obstetricians and reminder based on different trimesters is suggested to be refined to improve system acceptability and to decrease improper prescription.

Magid S, Forrer C, Shaha S. **Duplicate orders: an unintended consequence of computerized provider/physician order entry (CPOE) implementation: analysis and mitigation strategies**. Appl Clin Inform 2012;3(4):377-391.
Abstract: OBJECTIVE: Computerized provider/physician order entry (CPOE) with clinical decision support (CDS) is designed to improve patient safety. However, a number of unintended consequences which include duplicate ordering have been reported. The objective of this time-series study was to characterize duplicate orders and devise strategies to minimize them.
METHODS: Time series design with systematic weekly sampling for 84 weeks. Each week we queried the CPOE database, downloaded all active orders onto a spreadsheet, and highlighted duplicate orders. We noted the following details for each duplicate order: time, order details (e.g. drug, dose, route and frequency), ordering prescriber, including position and role, and whether the orders originated from a single order or from an order set (and the name of the order set). This analysis led to a number of interventions, including changes in: order sets, workflow, prescriber training, pharmacy procedures, and duplicate alerts.
RESULTS: Duplicates were more likely to originate from different prescribers than from same prescribers; and from order sets than from single orders. After interventions, there was an 84.8% decrease in the duplication rate from weeks 1 to 84 and a 94.6% decrease from the highest (1) to the lowest week (75). Currently, we have negligible duplicate orders.
CONCLUSIONS: Duplicate orders can be a significant unintended consequence of CPOE. By analyzing these orders, we were able to devise and implement generalizable strategies that significantly reduced them. The incidence of duplicate orders before CPOE implementation is unknown, and our data originate from a weekly snapshot of active orders, which serves as a sample of total active orders. Thus, it should be noted that this methodology

likely under-reports duplicate orders.

Magrabi F, Li SY, Day RO, Coiera E. **Errors and electronic prescribing: a controlled laboratory study to examine task complexity and interruption effects**. Journal of the American Medical Informatics Association: JAMIA2010. p. 575-583.
Abstract: OBJECTIVE: To examine the effect of interruptions and task complexity on error rates when prescribing with computerized provider order entry (CPOE) systems, and to categorize the types of prescribing errors. DESIGN: Two within-subject factors: task complexity (complex vs simple) and interruption (interruption vs no interruption). Thirty-two hospital doctors used a CPOE system in a computer laboratory to complete four prescribing tasks, half of which were interrupted using a counterbalanced design. MEASUREMENTS: Types of prescribing errors, error rate, resumption lag, and task completion time. RESULTS: Errors in creating and updating electronic medication charts that were measured included failure to enter allergy information; selection of incorrect medication, dose, route, formulation, or frequency of administration from lists and drop-down menus presented by the CPOE system; incorrect entry or omission in entering administration times, start date, and free-text qualifiers; and omissions in prescribing and ceasing medications. When errors occurred, the error rates across the four prescribing tasks ranged from 0.5% (1 incorrect medication selected out of 192 chances for selecting a medication or error opportunities) to 16% (5 failures to enter allergy information out of 32 error opportunities). Any impact of interruptions on prescribing error rates and task completion times was not detected in our experiment. However, complex tasks took significantly longer to complete ($F(1, 27)=137.9$; $p<0.001$) and when execution was interrupted they required almost three times longer to resume compared to simple tasks (resumption lag complex=9.6 seconds, SD=5.6; resumption lag simple=3.4 seconds, SD=1.7; $t(28)=6.186$; $p<0.001$). CONCLUSION: Most electronic prescribing errors found in this study could be described as slips in using the CPOE system to create and update electronic medication charts. Cues available within the user interface may have aided resumption of interrupted tasks making CPOE systems robust to some interruption effects. Further experiments are required to rule out any effect interruption might have on CPOE error rates.

McCoy AB, Waitman LR, Gadd CS, Danciu I, Smith JP, Lewis JB, et al. **A computerized provider order entry intervention for medication safety during acute kidney injury: a quality improvement report**. Am J Kidney Dis 2010;56(5):832-841.
Abstract: BACKGROUND: Frequently, prescribers fail to account for changing kidney function when prescribing medications. We evaluated the use of a computerized provider order entry intervention to improve medication management during acute kidney injury.
STUDY DESIGN: Quality improvement report with time series analyses.
SETTING & PARTICIPANTS: 1,598 adult inpatients with a minimum 0.5-mg/dL increase in serum creatinine level over 48 hours after an order for at least one of 122 nephrotoxic or renally cleared medications.
QUALITY IMPROVEMENT PLAN: Passive noninteractive warnings about increasing serum creatinine level appeared within the computerized provider order entry interface and on printed rounding reports. For contraindicated or high-toxicity medications that should be avoided or adjusted, an interruptive alert within the system asked providers to modify or discontinue the targeted orders, mark the current dosing as correct and to remain unchanged, or defer the alert to reappear in the next session.
OUTCOMES & MEASUREMENTS: Intervention effect on drug modification or discontinuation, time to modification or discontinuation, and provider interactions with alerts.
RESULTS: The modification or discontinuation rate per 100 events for medications included in the interruptive alert within 24 hours of increasing creatinine level improved from 35.2 preintervention to 52.6 postintervention ($P < 0.001$); orders were modified or

discontinued more quickly (P < 0.001). During the postintervention period, providers initially deferred 78.1% of interruptive alerts, although 54% of these eventually were modified or discontinued before patient death, discharge, or transfer. The response to passive alerts about medications requiring review did not significantly change compared with baseline.
LIMITATIONS: Single tertiary-care academic medical center; provider actions were not independently adjudicated for appropriateness.
CONCLUSIONS: A computerized provider order entry-based alerting system to support medication management after acute kidney injury significantly increased the rate and timeliness of modification or discontinuation of targeted medications.

Menendez MD, Alonso J, Rancano I, Corte JJ, Herranz V, Vazquez F. **Impact of computerized physician order entry on medication errors**. Revista de Calidad Asistencial 2012;27(6):334-340.
Abstract: BACKGROUND: Information is scarce on the impact of the clinical electronic record on the frequency and severity of medication errors in acute geriatric patients.
MATERIAL AND METHODS: An analytical and descriptive pre-post study was conducted on the implementation of computerized provider order entry systems (CPOE), over a 6 year period. A voluntary reporting system was used to detect the medication errors using the IR2 report form of the UK National Health Service, the Global Trigger Tool and the walk rounds with the Pharmacy Service. The severity categories were taken from the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) Index Categorizing Errors.
RESULTS: A total of 1887 medication errors (1553 patients) were detected in the period of study, and represented the first adverse event reported (29.3%). 8.5 adverse events per 100 admissions were found (0.24 in the categories E through I) and the prescription errors represented a 27.6%. By drugs dispensed, adverse events were 2.07 times more frequent in the 3 year period (2007-2009) with electronic clinical record than in the 3 year period with the hand-written system (2004-2006), being more frequent with antibiotics (1.92 times), antipyretic (2.21 times) and opiates (2.72 times). For serious errors and by doses dispensed, there were 5.18 times less frequent serious errors in the period related to the electronic record, drug omission (46.8 times less frequent), wrong dose (10.53 times) and antibiotics (10.84 times).
CONCLUSION: Frequent medication errors were found in acute geriatric patients. An increase in medication errors and a decline in the severity of the detected errors were found in relationship to the electronic clinical record. For these reasons, the implementation of the electronic clinical record should be monitored.

Netherton SJ, Lonergan K, Wang D, McRae A, Lang E. **Computerized physician order entry and decision support improves ED analgesic ordering for renal colic**. Am J Emerg Med 2014;32(9):958-961.
Abstract: OBJECTIVES: Computerized physician order entry (CPOE) offers the potential for safer, faster patient care, as well as greater use of evidence-based therapy via built-in decision support. However, the effectiveness of CPOE in yielding these benefits has shown mixed results in the emergency department (ED) setting. Our objective was to evaluate the impact of CPOE implementation on analgesic prescribing and dosing practices for renal colic presentations.
METHODS: This retrospective pre/post comparative study was conducted in 3 tertiary hospitals that implemented CPOE in 2010. Two patient groups were compared: prior to (pre-CPOE) and after (post-CPOE) CPOE implementation. Each group consisted of 230 randomly selected, high-acuity patients presenting to the ED with renal colic. The primary

outcome was the proportion of patients receiving ketorolac in the ED. Secondary outcomes included choice of analgesic and average morphine dose.
RESULTS: The proportion of patients receiving ketorolac significantly increased after CPOE implementation (65.6% pre-CPOE vs 76.5% post-CPOE, P = .015), as did the proportion of patients receiving fentanyl (pre, 9.7%; post, 16.7%; P = .047). Differences in morphine use (pre, 66.0%; post, 69.1%) and average morphine dose (pre, 10.09 mg; post, 12.28 mg) did not reach statistical significance.
CONCLUSIONS: The introduction of CPOE is associated with an increase in ketorolac use for ED renal colic visits. This may reflect the inclusion of ketorolac in the renal colic order set. Computerized physician order entry implementation with condition-specific electronic order sets and decision support may improve evidence-based practice.

Po JL, Nguyen BQ, Carling PC. **The impact of an infectious diseases specialist-directed computerized physician order entry antimicrobial stewardship program targeting linezolid use**. Infect Control Hosp Epidemiol 2012;33(4):434-435.
Abstract:

Potasman I, Naftali G, Grupper M. **Impact of a computerized integrated antibiotic authorization system**. Israel Medical Association Journal: Imaj 2012;14(7):415-419.
Abstract: BACKGROUND: Overuse and abuse of antibiotics is a major cause of microbial resistance. Within the hospital setting such overuse necessitates real-time supervision by infectious diseases (ID) specialists.
OBJECTIVES: To evaluate the impact of a recently introduced computerized antibiotic authorization system on the pharmacy budget.
METHODS: The study was performed in a 400 bed university hospital. With the new system, antibiotic requests are entered electronically by the ward physician and reviewed within minutes to hours by ID specialists. The feedbacks are seen in the wards and pharmacy. Successive years, one before and the other after introduction of the system, were compared.
RESULTS: During the first year with the new system 7167 antibiotic requests were entered; 20% of them were rejected, mainly for improper indication (43% of the rejections). During that year the antibiotic expenditure was reduced by 17%, compared to the previous year (approximately equal to 200,000 US$), and was against the trend of the last 5 years. Of the 35 antibiotics under the control of the ID team, the use of 7 was probably curtailed by the supervision. Pareto analysis revealed that four drugs constituted > 50% of the pharmacy's expenses. The mortality rate (per 1000 hospitalization days) during those 2 years fell from 4.0 to 3.8.
CONCLUSIONS: Computerized antibiotic control by ID specialists is a feasible cost-saving new modality that may help reduce unnecessary antibiotic prescriptions.

Prewitt J, Schneider S, Horvath M, Hammond J, Jackson J, Ginsberg B. **PCA safety data review after clinical decision support and smart pump technology implementation**. Journal of patient safety 2013;9(2):103-109.
Abstract: INTRODUCTION: Medication errors account for 20% of medical errors in the United States with the largest risk at prescribing and administration. Analgesics or opioids are frequently used medications that can be associated with patient harm when prescribed or administered improperly. In an effort to decrease medication errors, Duke University Hospital implemented clinical decision support via computer provider order entry (CPOE) and "smart pump" technology, 2/2008, with the goal to decrease patient-controlled analgesia (PCA) adverse events.
METHODS: This project evaluated PCA safety events, reviewing voluntary report system and adverse drug events via surveillance (ADE-S), on intermediate and step-down units

preimplementation and postimplementation of clinical decision support via CPOE and PCA smart pumps for the prescribing and administration of opioids therapy in the adult patient requiring analgesia for acute pain.
DISCUSSION: Voluntary report system and ADE-S PCA events decreased based upon 1000 PCA days; ADE-S PCA events per 1000 PCA days decreased 22%, from 5.3 (pre) to 4.2 (post) (P = 0.09). Voluntary report system events decreased 72%, from 2.4/1000 PCA days (pre) to 0.66/1000 PCA days (post) and was statistically significant (P < 0.001). There was a difference in the ADE-S data for causality (P < 0.0001) with sleep apnea and renal insufficiency approaching significance. Voluntary report system safety event were statistically significant for obesity [body mass index (BMI) >30] and weight.
CONCLUSION: This study demonstrated a decrease in PCA events between time periods in both the ADE-S and voluntary report system data, thus supporting the recommendation of clinical decision support via CPOE and PCA smart pump technology.

Refuerzo JS, Straub H, Murphy R, Salter L, Ramin SM, Blackwell SC. **Computerized physician order entry reduces medication turnaround time of labor induction agents**. Am J Perinatol 2011;28(4):253-258.
Abstract: We sought to determine whether computerized physician order entry (CPOE) improves the induction agent turnaround time on the labor and delivery unit (L&D) compared with paper-based order entry (PBOE). We conducted a retrospective study of singleton, term pregnancies admitted to L&D for induction of labor. Outcomes of women who delivered 3 months before or 3 months after universal CPOE implementation were compared including induction agent turnaround time. The induction agent turnaround time was significantly shorter in the CPOE group (N = 83) compared with PBOE group (N = 71) [71 (range 8 to 411) versus 100 (2 to 442) minutes, P = 0.004]. There were no differences in cesarean section rate or length of hospital stay. After controlling for time of day of induction, induction agent, and type of order entry, CPOE continued to significantly decrease the induction agent turnaround time by 25 minutes (P = 0.042). CPOE improved the process of induction of labor and efficiency of care of pregnant women.

Singh H, Mani S, Espadas D, Petersen N, Franklin V, Petersen LA. **Prescription errors and outcomes related to inconsistent information transmitted through computerized order entry: a prospective study**. Arch Intern Med 2009;169(10):982-989.
Abstract: BACKGROUND: Although several types of computerized provider order entry (CPOE)-related errors may occur, errors related to inconsistent information within the same prescription (ie, mismatch between the structured template and the associated free-text field) have not been described, to our knowledge. We determined the nature and frequency of such errors and identified their potential predictive variables.
METHODS: In this prospective study, we enrolled pharmacists to report prescriptions containing inconsistent communication over a 4-month period at a tertiary care facility. We also electronically retrieved all prescriptions written during the study period containing any comments in the free-text field and then randomly selected 500 for manual review to determine inconsistencies between free-text and structured fields. Of these, prescriptions without inconsistencies were categorized as controls. Data on potentially predictive variables from reported and unreported errors and controls were collected. For all inconsistencies, we determined their nature (eg, drug dosage or administration schedule) and potential harm and used multivariate logistic regression models to identify factors associated with errors and harm.
RESULTS: Of 55 992 new prescriptions, 532 (0.95%) were reported to contain inconsistent communication, a rate comparable to that obtained from the unreported group. Drug dosage was the most common inconsistent element among both groups. Certain medications were more likely associated with errors, as was the inpatient setting (odds ratio, 3.30;

95% confidence interval, 2.18-5.00) and surgical subspecialty (odds ratio, 2.45; 95% confidence interval, 1.57-3.82). About 20% of errors could have resulted in moderate to severe harm, for which significant independent predictors were found.
CONCLUSIONS: Despite standardization of data entry, inconsistent communication in CPOE poses a significant risk to safety. Improving the usability of the CPOE interface and integrating it with workflow may reduce this risk.

Sistrom CL, Dang PA, Weilburg JB, Dreyer KJ, Rosenthal DI, Thrall JH. **Effect of computerized order entry with integrated decision support on the growth of outpatient procedure volumes: seven-year time series analysis**. Radiology2009. p. 147-155.
Abstract: PURPOSE: To determine the effect of a computerized radiology order entry (ROE) and decision support (DS) system on growth rate of outpatient computed tomography (CT), magnetic resonance (MR) imaging, and ultrasonography (US) procedure volumes over time at a large metropolitan academic medical center. MATERIALS AND METHODS: Institutional review board approval was obtained for this study of deidentified aggregate administrative data. The research was compliant with HIPAA; informed consent was waived. This was a retrospective study of outpatient advanced imaging utilization before, during, and after implementation of a Web-based ROE and DS system. Dependent variables were the quarterly volumes of outpatient CT, MR imaging, and US examinations from quarter 4 of 2000 through quarter 4 of 2007. Outpatient visits during each quarter were included as control variables. These data were analyzed as three separate time series with piecewise linear regression for simultaneous estimation of quarterly examination volume trends before and after ROE and DS system implementation. This procedure was repeated with log-transformed quarterly volumes to estimate percentage growth rates. RESULTS: There was a significant decrease in CT volume growth (274 per quarter) and growth rate (2.75% per quarter) after ROE and DS system implementation ($P < .001$). For MR imaging, growth rate decreased significantly (1.2%, $P = .016$) after ROE and DS system implementation; however, there was no significant change in quarterly volume growth. With US, quarterly volume growth ($n = 98$, $P = .014$) and growth rate (1.3%, $P = .001$) decreased significantly after ROE implementation. These changes occurred during a steady growth in clinic visit volumes in the associated referral practices. CONCLUSION: Substantial decreases in the growth of outpatient CT and US procedure volume coincident with ROE implementation (supplemented by DS for CT) were observed. The utilization of outpatient MR imaging decreased less impressively, with only the rate of growth being significantly lower after interventions were in effect

Sowan AK, Gaffoor MI, Soeken K, Johantgen ME, Vaidya VU. **Impact of computerized orders for pediatric continuous drug infusions on detecting infusion pump programming errors: a simulated study**. J Pediatr Nurs 2010;25(2):108-118.
Abstract: Continuous infusion medications are associated with fatal adverse events in pediatric intensive care units. The effect of computerized orders on detecting infusion pumps programming errors has never been studied. Using a crossover design, we examined the effect of using computerized orders for continuous infusions as compared with that of using handwritten orders on nurse ability to detect infusion pump programming errors, time required to verify pump settings, and user satisfaction. The computerized orders saved nurses time but did not improve their ability to detect infusion pumps programming errors. Nurses preferred computerized orders. High error rate was related to manual calculations and inconsistent use of computerized orders.

Spalding SC, Mayer PH, Ginde AA, Lowenstein SR, Yaron M. **Impact of computerized physician order entry on ED patient length of stay**. Am J Emerg Med 2011;29(2):207-211.
Abstract: OBJECTIVES: We evaluated whether implementation of computerized physician

order entry (CPOE) reduces length of stay (LOS) for discharged emergency department (ED) patients.
METHODS: Emergency department LOS for discharged and admitted patients were analyzed in a university-affiliated ED before and after introduction of CPOE. Patient demographics and covariates that may affect LOS (mode of arrival, provider staffing, daily census, and admission rate) were measured.
RESULTS: The study included 71,188 patients; 49,175 (69%) were discharged from the ED (28, 687 before and 20,488 after CPOE). Length of stay for discharged patients decreased from 198 to 168 minutes (difference of -30; 95% confidence interval [CI], -28 to -33), whereas LOS for admitted patients increased from 405 to 441 minutes (difference of +36; 95% CI, 26-46). After controlling for covariates, CPOE implementation was associated with a 23-minute decrease in LOS for discharged patients (beta = -23 [95% CI, -26 to -19]).
CONCLUSION: Implementation of CPOE was associated with a clinically significant (23-minute) decrease in LOS among patients who were discharged from the ED.

Stone WM, Smith BE, Shaft JD, Nelson RD, Money SR. **Impact of a computerized physician order-entry system**. J Am Coll Surg 2009;208(5):960-967; discussion 967-969.
Abstract: BACKGROUND: The Institute of Medicine has urged the adoption of electronic prescribing systems in all health-care organizations by 2010. Accordingly, computerized physician order entry (CPOE) warrants detailed evaluation. Mixed results have been reported about the benefit of this system. No review of its application in surgical patients has been reported to date. We present the implementation of CPOE in the management of surgical patients within an academic multispecialty practice.STUDY DESIGN: Retrospective and prospective analyses of patient-safety measures were done pre- and post-CPOE institution, respectively. Other metrics evaluated included medication errors, order-implementation times, efficiencies, personnel requirements, and physician time. Sampling of time span for the order placement process was assessed with direct hidden observation of the provider.
RESULTS: A total of 15 (0.22%) medication errors were discovered in 6,815 surgical procedures performed during the 6 months before CPOE use. After implementation, 10 medication errors were found (5,963 surgical procedures [0.16%]) in the initial 6 months and 13 (0.21%) in the second 6 months (6,106 surgical procedures) (p = NS). Mean total time from placement of order to nurse receipt before implementation was 41.2 minutes per order (2.05 minutes finding chart, 0.72 minutes writing order, 38.4 minutes for unit secretary transcription) compared with 27 seconds per order using CPOE (p < 0.01). Four additional informational technology specialists were temporarily required for assistance in implementing CPOE. After CPOE adoption, 11 of 56 (19.6%) ancillary personnel positions were eliminated related to order-entry efficiencies.
CONCLUSIONS: Present CPOE technology can allow major efficiency gains, but refinements will be required for improvements in patient safety.

Taylor JA, Loan LA, Kamara J, Blackburn S, Whitney D. **Medication administration variances before and after implementation of computerized physician order entry in a neonatal intensive care unit**. Pediatrics 2008;121(1):123-128.
Abstract: OBJECTIVE: The goal was to determine whether implementation of a computerized physician order entry system was associated with a decrease in medication administration variances in a NICU.
METHODS: A prospective observational study was conducted. Research nurses recorded details of medication administrations for patients in a NICU during standardized observation periods. Details of each administration were compared with the medication order; a variance was defined as a discrepancy between the order and the medication administration. Rates of variances before and after implementation of computerized physician order

entry in the NICU were compared. Specific types of and reasons for variances were also compared.
RESULTS: Data on 526 medication administrations, including 254 during the pre-computerized physician order entry period and 272 after implementation of computerized physician order entry, were collected. Medication variances were detected for 19.8% of administrations during the pre-computerized physician order entry period, compared with 11.6% with computerized physician order entry (rate ratio: 0.53). Overall, administration mistakes, prescribing problems, and pharmacy problems accounted for 74% of medication variances; there were no statistically significant differences in rates for any of these specific reasons before versus after introduction of computerized physician order entry. Administration of a medication at the wrong time accounted for 53.1% of all variances. Variance rates related to giving a drug at the wrong time were significantly lower in the computerized physician order entry period than in the pre-computerized physician order entry period (rates: 6.7% and 9.9%, respectively; rate ratio: 0.53).
CONCLUSIONS: Implementation of computerized physician order entry in a NICU was associated with a significant decrease in the rate of medication administration variances. However, even with the use of computerized physician order entry, variances were noted for >11% of all medication administrations, which suggests that additional methods may be needed to improve neonatal patient safety.

Vermeulen KM, van Doormaal JE, Zaal RJ, Mol PG, Lenderink AW, Haaijer-Ruskamp FM, et al. **Cost-effectiveness of an electronic medication ordering system (CPOE/CDSS) in hospitalized patients**. Int J Med Inform 2014;83(8):572-580.
Abstract: INTRODUCTION: Prescribing medication is an important aspect of almost all in-hospital treatment regimes. Besides their obviously beneficial effects, medicines can also cause adverse drug events (ADE), which increase morbidity, mortality and health care costs. Partially, these ADEs arise from medication errors, e.g. at the prescribing stage. ADEs caused by medication errors are preventable ADEs. Until now, medication ordering was primarily a paper-based process and consequently, it was error prone. Computerized Physician Order Entry, combined with basic Clinical Decision Support System (CPOE/CDSS) is considered to enhance patient safety. Limited information is available on the balance between the health gains and the costs that need to be invested in order to achieve these positive effects. Aim of this study was to study the balance between the effects and costs of CPOE/CDSS compared to the traditional paper-based medication ordering.
METHODS: The economic evaluation was performed alongside a clinical study (interrupted time series design) on the effectiveness of CPOE/CDSS, including a cost minimization and a cost-effectiveness analysis. Data collection took place between 2005 and 2008. Analyses were performed from a hospital perspective. The study was performed in a general teaching hospital and a University Medical Centre on general internal medicine, gastroenterology and geriatric wards. Computerized Physician Order Entry, combined with basic Clinical Decision Support System (CPOE/CDSS) was compared to a traditional paper based system. All costs of both medication ordering systems are based on resources used and time invested. Prices were expressed in Euros (price level 2009). Effectiveness outcomes were medication errors and preventable adverse drug events.
RESULTS: During the paper-based prescribing period 592 patients were included, and during the CPOE/CDSS period 603. Total costs of the paper-based system and CPOE/CDSS amounted to 12.37 and 14.91 per patient/day respectively. The Incremental Cost-Effectiveness Ratio (ICER) for medication errors was 3.54 and for preventable adverse drug events 322.70, indicating the extra amount () that has to be invested in order to prevent one medication error or one pADE.
CONCLUSIONS: CPOE with basic CDSS contributes to a decreased risk of preventable harm. Overall, the extra costs of CPOE/CDSS needed to prevent one ME or one pADE seem to be acceptable.

Walsh KE, Landrigan CP, Adams WG, Vinci RJ, Chessare JB, Cooper MR, et al. **Effect of computer order entry on prevention of serious medication errors in hospitalized children**. Pediatrics 2008;121(3):e421-427.

Abstract: OBJECTIVE: Although initial research suggests that computerized physician order entry reduces pediatric medication errors, no comprehensive error surveillance studies have evaluated the effect of computerized physician order entry on children. Our objective was to evaluate comprehensively the effect of computerized physician order entry on the rate of inpatient pediatric medication errors.
METHODS: Using interrupted time-series regression analysis, we reviewed all charts, orders, and incident reports for 40 admissions per month to the NICU, PICU, and inpatient pediatric wards for 7 months before and 9 months after implementation of commercial computerized physician order entry in a general hospital. Nurse data extractors, who were unaware of study objectives, used an established error surveillance method to detect possible errors. Two physicians who were unaware of when the possible error occurred rated each possible error.
RESULTS: In 627 pediatric admissions, with 12,672 medication orders written over 3234 patient-days, 156 medication errors were detected, including 70 nonintercepted serious medication errors (22/1000 patient-days). Twenty-three errors resulted in patient injury (7/1000 patient-days). In time-series analysis, there was a 7% decrease in level of the rates of nonintercepted serious medication errors. There was no change in the rate of injuries as a result of error after computerized physician order entry implementation.
CONCLUSIONS: The rate of nonintercepted serious medication errors in this pediatric population was reduced by 7% after the introduction of a commercial computerized physician order entry system, much less than previously reported for adults, and there was no change in the rate of injuries as a result of error. Several human-machine interface problems, particularly surrounding selection and dosing of pediatric medications, were identified. Additional refinements could lead to greater effects on error rates.

Westbrook JI, Baysari MT, Li L, Burke R, Richardson KL, Day RO. **The safety of electronic prescribing: manifestations, mechanisms, and rates of system-related errors associated with two commercial systems in hospitals**. J Am Med Inform Assoc 2013;20(6):1159-1167.

Abstract: OBJECTIVES: To compare the manifestations, mechanisms, and rates of system-related errors associated with two electronic prescribing systems (e-PS). To determine if the rate of system-related prescribing errors is greater than the rate of errors prevented.
METHODS: Audit of 629 inpatient admissions at two hospitals in Sydney, Australia using the CSC MedChart and Cerner Millennium e-PS. System related errors were classified by manifestation (eg, wrong dose), mechanism, and severity. A mechanism typology comprised errors made: selecting items from drop-down menus; constructing orders; editing orders; or failing to complete new e-PS tasks. Proportions and rates of errors by manifestation, mechanism, and e-PS were calculated.
RESULTS: 42.4% (n=493) of 1164 prescribing errors were system-related (78/100 admissions). This result did not differ by e-PS (MedChart 42.6% (95% CI 39.1 to 46.1); Cerner 41.9% (37.1 to 46.8)). For 13.4% (n=66) of system-related errors there was evidence that the error was detected prior to study audit. 27.4% (n=135) of system-related errors manifested as timing errors and 22.5% (n=111) wrong drug strength errors. Selection errors accounted for 43.4% (34.2/100 admissions), editing errors 21.1% (16.5/100 admissions), and failure to complete new e-PS tasks 32.0% (32.0/100 admissions). MedChart generated more selection errors (OR=4.17; p=0.00002) but fewer new task failures (OR=0.37; p=0.003) relative to the Cerner e-PS. The two systems prevented significantly more errors than they generated (220/100 admissions (95% CI 180 to 261) vs 78 (95% CI 66 to 91)).
CONCLUSIONS: System-related errors are frequent, yet few are detected. e-PS require new

tasks of prescribers, creating additional cognitive load and error opportunities. Dual classification, by manifestation and mechanism, allowed identification of design features which increase risk and potential solutions. e-PS designs with fewer drop-down menu selections may reduce error risk.

Westbrook JI, Georgiou A, Rob MI. **Computerised order entry systems: sustained impact on laboratory efficiency and mortality rates?** Stud Health Technol Inform 2008;136:345-350.

Abstract: Few studies have attempted to measure the effectiveness of computerised test-order entry systems to reduce test turnaround time and the extent to which improvements are sustained or continue over time. Further, a recent study has raised the possibility that such systems, which require significant work practice change, may be associated with an increase in mortality rates. Our study answered two questions in relation to the introduction of a computerised pathology order entry system in a major Australian teaching hospital: i) are initial improvements in turnaround times achieved in the first 12 months of system use sustained beyond this time; and ii) did mortality rates change following the introduction of the order entry system? We found significant improvements in turnaround times 12 and 24 months following system implementation and no change in average number of tests per patient. The mortality rate significantly increased in the year following system introduction but returned to the pre-system rate in the second year of system use. Review of the excess deaths demonstrated that these were most likely attributable to a coincidental influenza outbreak and not to system introduction. The computerised order entry systems produced sustained and continuing improvements in health care delivery efficiency over a two year period. Associations between increased mortality rates and system introduction should be investigated carefully to ascertain any likely association.

Westbrook JI, Li L, Georgiou A, Paoloni R, Cullen J. **Impact of an electronic medication management system on hospital doctors' and nurses' work: a controlled pre-post, time and motion study**. J Am Med Inform Assoc 2013;20(6):1150-1158.

Abstract: OBJECTIVE: To quantify and compare the time doctors and nurses spent on direct patient care, medication-related tasks, and interactions before and after electronic medication management system (eMMS) introduction.

METHODS: Controlled pre-post, time and motion study of 129 doctors and nurses for 633.2 h on four wards in a 400-bed hospital in Sydney, Australia. We measured changes in proportions of time on tasks and interactions by period, intervention/control group, and profession.

RESULTS: eMMS was associated with no significant change in proportions of time spent on direct care or medication-related tasks relative to control wards. In the post-period control ward, doctors spent 19.7% (2 h/10 h shift) of their time on direct care and 7.4% (44.4 min/10 h shift) on medication tasks, compared to intervention ward doctors (25.7% (2.6 h/shift; p=0.08) and 8.5% (51 min/shift; p=0.40), respectively). Control ward nurses in the post-period spent 22.1% (1.9 h/8.5 h shift) of their time on direct care and 23.7% on medication tasks compared to intervention ward nurses (26.1% (2.2 h/shift; p=0.23) and 22.6% (1.9 h/shift; p=0.28), respectively). We found intervention ward doctors spent less time alone (p=0.0003) and more time with other doctors (p=0.003) and patients (p=0.009). Nurses on the intervention wards spent less time with doctors following eMMS introduction (p=0.0001).

CONCLUSIONS: eMMS introduction did not result in redistribution of time away from direct care or towards medication tasks. Work patterns observed on these intervention wards were associated with previously reported significant reductions in prescribing error rates relative to the control wards.

Uønskede hendelser (meldeordninger)

Ikke-randomiserte studier og observasjonelle design
Rommers MK, Teepe-Twiss IM, Guchelaar HJ. **A computerized adverse drug event alerting system using clinical rules: a retrospective and prospective comparison with conventional medication surveillance in the Netherlands**. Drug Saf 2011;34(3):233-242. Abstract: BACKGROUND: Adverse drug events (ADEs) are an important problem in hospital practice. Computerized physician order entry (CPOE) and clinical decision support systems (CDSS) are useful tools in the prevention of ADEs. In the Netherlands there are some basic CDSS within CPOE systems, but there is not much experience with sophisticated systems. We have recently developed a more advanced CDSS, a computerized adverse drug event alerting system (ADEAS). OBJECTIVE: The aim of the study was to compare the newly developed ADEAS, which uses a set of clinical rules, with the conventional medication surveillance, a basic CDSS within a CPOE, to assess its additional value in detecting patients with a potential ADE. SETTING: Leiden University Medical Center (LUMC), a university hospital in Leiden, the Netherlands. DESIGN: Two studies were carried out; one retrospective and one prospective. The retrospective comparison of ADEAS with conventional medication surveillance was conducted on all patients admitted to the hospital (except intensive care unit patients) during a 1-month period (15 November-15 December 2006). A prospective comparison of both systems was performed during a 6-month period (May-October 2007) on one general internal medicine ward. MEASUREMENTS: The endpoint was the total number of alerts and content of alerts generated by both methods. In the prospective study we also focused on the number of unique alerts and interventions by the hospital pharmacist following the alerts. RESULTS: In the retrospective study, ADEAS generated 2010 alerts compared with 2322 generated by the conventional method. In the prospective study, 248 and 177 alerts were generated by ADEAS and the conventional method, respectively. The number of unique alerts was 85 (of which 72 were considered true positive alerts) and 136, respectively. The hospital pharmacist made 14 (19.4%) interventions following a true positive alert with ADEAS and 5 (3.7%) with the conventional method. The contents of alerts generated by ADEAS were different to the safety alerts generated by conventional medication surveillance. The conventional medication surveillance generated safety alerts regarding drug-drug interactions and drug-overdosing. ADEAS generated alerts regarding declined renal function or other laboratory abnormalities and absence of essential concurrent medication. CONCLUSIONS: Compared with our conventional medication surveillance, the computerized alert system ADEAS selected different patients at risk for an ADE. This makes ADEAS in our hospital of additional value to the hospital pharmacist as a suitable tool in reducing the number of preventable ADEs.
Stockwell DC, Kirkendall E, Muething SE, Kloppenborg E, Vinodrao H, Jacobs BR. **Automated adverse event detection collaborative: electronic adverse event identification, classification, and corrective actions across academic pediatric institutions**. Journal of patient safety 2013;9(4):203-210. Abstract: BACKGROUND: Historically, the gold standard for detecting medical errors has

been the voluntary incident reporting system. Voluntary reporting rates significantly underestimate the number of actual adverse events in any given organization. The electronic health record (EHR) contains clinical and administrative data that may indicate the occurrence of an adverse event and can be used to detect adverse events that may otherwise remain unrecognized. Automated adverse event detection has been shown to be efficient and cost effective in the hospital setting. The Automated Adverse Event Detection Collaborative (AAEDC) is a group of academic pediatric organizations working to identify optimal electronic methods of adverse event detection. The Collaborative seeks to aggregate and analyze data around adverse events as well as identify and share specific intervention strategies to reduce the rate of such events, ultimately to deliver higher quality and safer care. The objective of this study is to describe the process of automated adverse event detection, report early results from the Collaborative, identify commonalities and notable differences between 2 organizations, and suggest future directions for the Collaborative.
METHODS: In this retrospective observational study, the implementation and use of an automated adverse event detection system was compared between 2 academic children's hospital participants in the AAEDC, Children's National Medical Center, and Cincinnati Children's Hospital Medical Center. Both organizations use the EHR to identify potential adverse events as designated by specific electronic data triggers. After gathering the electronic data, a clinical investigator at each hospital manually examined the patient record to determine whether an adverse event had occurred, whether the event was preventable, and the level of harm involved.
RESULTS: The Automated Adverse Event Detection Collaborative data from the 2 organizations between July 2006 and October 2010 were analyzed. Adverse event triggers associated with opioid and benzodiazepine toxicity and intravenous infiltration had the greatest positive predictive value (range, 47%- 96%). Triggers associated with hypoglycemia, coagulation disturbances, and renal dysfunction also had good positive predictive values (range, 22%-74%). In combination, the 2 organizations detected 3,264 adverse events, and 1,870 (57.3%) of these were preventable. Of these 3,264 events, clinicians submitted only 492 voluntary incident reports (15.1%).
CONCLUSIONS: This work demonstrates the value of EHR-derived data aggregation and analysis in the detection and understanding of adverse events. Comparison and selection of optimal electronic trigger methods and recognition of adverse event trends within and between organizations are beneficial. Automated detection of adverse events likely contributes to the discovery of opportunities, expeditious implementation of process redesign, and quality improvement.

Folkehelse (meldeordninger)

Ikke-randomiserte studier og observasjonelle design

Overhage JM, Grannis S, McDonald CJ. **A comparison of the completeness and timeliness of automated electronic laboratory reporting and spontaneous reporting of notifiable conditions**. Am J Public Health 2008;98(2):344-350.
Abstract: OBJECTIVES: We examined whether automated electronic laboratory reporting of notifiable-diseases results in information being delivered to public health departments more completely and quickly than is the case with spontaneous, paper-based reporting.
METHODS: We used data from a local public health department, hospital infection control departments, and a community-wide health information exchange to identify all potential cases of notifiable conditions that occurred in Marion County, Ind, during the first quarter

of 2001. We compared traditional spontaneous reporting to the health department with automated electronic laboratory reporting through the health information exchange.
RESULTS: After reports obtained using the 2 methods had been matched, there were 4785 unique reports for 53 different conditions during the study period. Chlamydia was the most common condition, followed by hepatitis B, hepatitis C, and gonorrhea. Automated electronic laboratory reporting identified 4.4 times as many cases as traditional spontaneous, paper-based methods and identified those cases 7.9 days earlier than spontaneous reporting.
CONCLUSIONS: Automated electronic laboratory reporting improves the completeness and timeliness of disease surveillance, which will enhance public health awareness and reporting efficiency.

Rosenman MB, Szucs KA, Finnell SME, Khokhar S, Egg J, Lemmon L, et al. **Nascent regional system for alerting infection preventionists about patients with multidrug-resistant gram-negative bacteria: Implementation and initial results**. Infect Control Hosp Epidemiol 2014;35:S40-S47.
Abstract: objective. To build and to begin evaluating a regional automated system to notify infection preventionists (IPs) when a patient with a history of gram-negative rod multidrug-resistant organism (GNRMDRO) is admitted to an emergency department (ED) or inpatient setting. Design. Observational, retrospective study. Setting. Twenty-seven hospitals, mostly in the Indianapolis metropolitan area, in a health information exchange (HIE). Patients. During testing of the new system: 80,180 patients with microbiology cultures between October 1, 2013, and December 31, 2013; 573 had a GNRMDRO. Methods/Intervention. A Health Level Seven (HL7) data feed from the HIE was obtained, corrected, enhanced, and used for decision support (secure e-mail notification to the IPs). Retrospective analysis of patients with microbiology data (October 1, 2013, through December 31, 2013) and subsequent healthcare encounters (through February 6, 2014). Results. The 573 patients (median age, 66 years; 68% women) had extended-spectrum beta-lactamase-producing Enterobacteriaceae (78%), carbapenem-resistant Enterobacteriaceae (7%), Pseudomonas aeruginosa (9%), Acinetobacter baumannii (3%), or other GNR (3%). Body sources were urine (68%), sputum/trachea/bronchoalveolar lavage (13%), wound/skin (6%), blood (6%), or other/unidentified (7%). Between October 1, 2013, and February 6, 2014, 252 (44%) of 573 had an ED or inpatient encounter after the GNRMDRO culture, 47 (19% of 252) at an institution different from where the culture was drawn. During the first 7 weeks of actual alerts (January 29, 2014, through March 19, 2014), alerts were generated regarding 67 patients (19 of 67 admitted elsewhere from where the culture was drawn). conclusions. It proved challenging but ultimately feasible to create a regional microbiology-based alert system. Even in a few months, we observed substantial crossover between institutions. This system, if it contributes to timely isolation, may help reduce the spread of GNRMDROs.

Shapiro JS, Genes N, Kuperman G, Chason K, Clinical Advisory Committee H1N1 Working Group NYCIE, Richardson LD. **Health information exchange, biosurveillance efforts, and emergency department crowding during the spring 2009 H1N1 outbreak in New York City**. Ann Emerg Med 2010;55(3):274-279.
Abstract: Novel H1N1 influenza spread rapidly around the world in spring 2009. Few places were as widely affected as the New York metropolitan area. Emergency departments (EDs) in the region experienced daily visit increases in 2 distinct temporal peaks, with means of 36.8% and 60.7% over baseline in April and May, respectively, and became, in a sense, the "canary in the coal mine" for the rest of the country as we braced ourselves for resurgent spread in the fall. Biosurveillance efforts by public health agencies can lead to earlier detection, potentially forestalling spread of outbreaks and leading to better situational awareness by frontline medical staff and public health workers as they respond to a

crisis, but biosurveillance has traditionally relied on manual reporting by hospital administrators when they are least able: in the midst of a public health crisis. This article explores the use of health information exchange networks, which enable the secure flow of clinical data among otherwise unaffiliated providers across entire regions for the purposes of clinical care, as a tool for automated biosurveillance reporting. Additionally, this article uses a health information exchange to assess H1N1's effect on ED visit rates and discusses preparedness recommendations and lessons learned from the spring 2009 H1N1 experience across 11 geographically distinct EDs in New York City that participate in the health information exchange.

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