Reference	Patient Sample and Time Frame	Sampling Strategy	Specialty	Events Identified	Automated Event Dataset Sample Size	Comparison Event Dataset Sample Size	Strategy of Event Identification	Method of Automated Event Identification	Degree of Automation	Source of Automated Event Data	Source of Comparison Event Data	Method of Comparison Event Identification	Comments
Complications Screening Program													
Lawthers, 2000 [10]	Adults 1994	Combination of random sample and risk stratification sampling	Major surgical and medical risk groups	Adverse events: "complications of hospital care"	1298 cases: 634 California, 664 Connecticut	1298 cases	Complications Screening Program	Field Defined	Partial	ICD-9 CM codes	Medical record and ICD-9 CM codes	Chart review, not otherwise specified	Used ICD-9 CM codes to screen for complications. When code was triggered, computer algorithm tested for specific qualifications to categorize the complication further. This study used Medicare 1994 MEDPRO database claim codes and a 2 stage review to compare the codes to manual review. Study designed with chart review after computerized detection. Number of cases per screen were relatively small. Reviewers unblinded to trigger codes.
Weingart, 2000 [9]	Geriatrics 1994	Random	Unknown	Adverse Event: complications of care including surgical complications, infections, falls, ADE etc	1025 Medicare beneficiaries	NA	Complications Screening Program	Field Defined	Partial	Administrative Data	NA	NA	Used administrative data from Medicare patients in California and Connecticut in 1994. Hospitals stratified by expected complication rates, then randomly selected cases flagged with surgical and medical complications as well as unflagged controls were collected. Cases subjected to peer review physician judgments to attempt to validate the CSP.
Iezzoni, 1992 [8]	Adults 1988	Unknown	Gen Med and Gen Surg (excluded obstetric patients)	Adverse events	100 discharge abstracts. Original sample size unknown.	100 standard hospital discharge abstracts	Appears to be Complications Screening Program (CSP) or a precursor to CSP.	Field Defined	Partial	Discharge summary; ICD-9 diagnosis and procedure codes	Discharge summary and administrative data	Chart review, not otherwise specified	Computerized screening based on patient age, sex, ICD-9-CM diagnosis and procedure codes, DRG, and number of days from admission to principal major surgeries or procedures. 27 quality screens used to identify potential adverse events. Physician reviewers only had access to administrative data and had poor inter-rater reliability.
Computer Algorithms													
Nebeker, 2007 [18]	Adults 2001 and 2003	Random	Unknown	Adverse drug events	3987 admissions	3987 admissions	Computer algorithms	Field Defined	Chart review for study, however unclear whether strategy aims to be fully or partially automated.	ICD-9 CM codes	Medical record	Gold standard chart review	Study used Hougland, 2006 [28] methodology to specifically apply HOCTA (hierarchically optimal classification tree analysis) to administrative data to develop surveillance rules for the identification of ADEs manifesting as either bleeding or delirium. Specifically interested in creating models using this type of nonlinear statistical method for 2 particular ADEs. Model's validation was limited and may be overfit. Requires expert computer programming.
Trick, 2004 [20]	Adults 9/1/01-2/28/02	Sequential	Unknown	Infection	135 positive blood cultures	144 positive blood cultures	Computer algorithm	Field Defined	Full and Partial	Medical record, lab database, pharmacy database, radiology database, microbiology	Medical record, lab database, pharmacy, radiology, microbiology	Gold standard chart review	Comparison of manual and computer assisted bloodstream central venous catheter infection surveillance using data from two hospitals. Different computer algorithms developed for full or partial automation were tested. Findings may not generalize to other institutions.
Benson, 2000 [19]	Patients aged 14 years and older 1998	Sequential	Patients under anesthesia	Adverse Event	16,019 surgical procedures	16,019 surgical procedures	Computer algorithm: structure query language	Field Defined	Full	Online anesthesia documenting software (Anesthesia Information Management System, or AIMS)	Anesthesia record	Other: manually recorded information during perioperative period by anesthesiologist	AIMS database queried for 9 common perioperative adverse events with structured query language (SQL) queries.

Study	Population / Dates		Setting	Event	Cases	Denominator	System	Definition		Data sources	Comparison 1	Comparison 2	Description
Brown, 2000 [21]	Unknown 7/1/99 to 9/30/99	Sequential	Unknown	Adverse drug events	1643 RADARx alerts over study period	Unknown	Computer Algorithms: RADARx	Field Defined	Partial	Lab database, pharmacy database, demographics, diagnoses and procedures	Unknown	Other: "traditional methods", not otherwise specified	RADARx (Recognizing, Assessing, and Documenting Adverse Rx events) is a VA software program integrating computerized adverse drug event (ADE) screening, probability assessment, documentation and reporting capabilities. Study evaluated patient data every four hours for possible ADEs, generated and stored alerts. Clinical pharmacists reviewed alerts daily, documented findings, and contacted clinicians in real-time. Used Naranjo algorithm to assess causality. Major source of algorithm rules from Jha, 1998 [30]. Manual review of 8-20 alerts daily costed 10-30 minutes daily. RADARx used 12 seconds of CPU time every 4 hours. Initially involved 30 minutes installation time and 1-2 hours to run mapping tools. RADARx rules designed as screens and meant to be sensitive and not specific.
HELP: Health Evaluation through Logical Processing													
Samore, 2004 [13]	Adults 1/00 -9/00	Sequential	Other: all "regular and short stay" pts except obstetrics and neonates.	Adverse medical device events	20,441 pts	20,441 pts	HELP and computer based flags	Field Defined	Partial	Medical record, lab database, pharmacy database, radiology database, billing data, ICD-9 CM codes - HELP integrates multiple interfaces	Voluntary reporting and ICD-9 CM codes	Voluntary reporting and ICD-9 discharge codes	Automated surveillance designed to detect device related patient harm (AMDE) based on existing HELP adverse drug event detection methods. 7 categories of automated flags based on common complications and availability of electronic data, then flagged charts reviewed manually. AMDE definition includes all definitions of harm such as infection, bleeding, dropping oxygen saturations etc.
Classen, 1991 [11]	Adults 5/1/89 to 10/31/90	Sequential	Obstetrics, ICU, Gen Med and Gen Surg	Adverse drug events	36,653 patients	NA	HELP	Field Defined	Partial	Medical record, lab database, pharmacy database	Voluntary reporting	voluntary reporting and stimulated voluntary reporting	Results from the HELP system at the LDS Hospital, Utah using highly integrated electronic medical record. Daily computerized ADE report generated from automated surveillance of the medical record for defined signals, followed by clinical pharmacist review.
Evans, 1991 [12]	Unknown 5/89-5/90	Sequential	Unknown	Adverse drug events	23,297 patients	25,142 patients from 5/1/88-5/1/89	HELP	Field Defined	Partial	Medical record, lab database, pharmacy database, demographics	Voluntary reporting	voluntary reporting	Results from HELP information system at LDS hospital in Utah. ADE monitor program generated daily list of alerts using automated signals. Signaled charts were reviewed by trained nurse and pharmacist to verify ADE. Based on Classen 1991 [8] rules/program.
Evans, 1986 [14]	Unknown 2/84 to 3/84	Sequential	Unknown	Infection	4,679 patients; 217 with suspected NI	217 patients with suspected NI	HELP and other	Field Defined	Partial	Medical record, lab database, microbiology test results	Medical record	Chart review, not otherwise specified	Study evaluated computer screening versus infection control practitioner screening, both followed by chart review. The overall computerized system looked at patients with 1) hospital-acquired infections, 2) who were not receiving antibiotics to which their pathogens were susceptible, 3) who could be receiving less expensive antibiotics, or 4) who were receiving prophylactic antibiotics for too long. Time required: 8.6 hours to complete computerized report of unverified alerts, compared to 138 hours for infection control practitioners. Physician review took 15 minutes per chart to verify alerts.
Natural Language Processing													
Haas, 2005 [49]	Children 3/1/01-1/31/03	Sequential	NICU	Pneumonia	1692 patients	1692 patients	Natural Language Processing	Natural Language Processing	Full	Radiology database: specifically chest x-rays	Radiology database, medical record, microbiology, interviews with caregivers	Prospective infection surveillance by experienced infection control professional.	Designed to use chest x-rays from two neonatal intensive care units to detect nosocomial pneumonia in neonates. NLP program screened chest x ray reports and flagged reports indicative of pneumonia according to rules derived from National Nosocomial Infection Surveillance System.

Author, Year	Population/Years	Sampling	Specialty	Harm Type	Denominator	Numerator	Method	Method Type	Full/Partial	Data Source	Gold Standard Source	Gold Standard	Comments
Melton, 2005 [48]	Unknown 1996-2000	Random sampling and Sequential (all electronic discharge summaries during study years)	Unknown	Adverse events: specifically 45 NYPORTS event types.	1000 charts randomly sampled and then 57,422 electronic discharge summaries	1000 charts (random sample during study period)	Natural Language Processing	Natural Language Processing	Partial	Discharge summaries	Full electronic chart and combined electronic chart and paper chart for a subset of 100 pts.	Gold standard chart review	Natural Language Processing system (MedLEE) to identify 45 NY Patient Occurrence Reporting and Tracking System event types. Discharge summaries converted to coded form then tested. Chart review by physician and independant informatician of random sample of 1000 charts to assess performance of NLP program. Results biased towards patients with electronic discharge summaries. This method is technologically intensive.

Patient Safety Indicators

Author, Year	Population/Years	Sampling	Specialty	Harm Type	Denominator	Numerator	Method	Method Type	Full/Partial	Data Source	Gold Standard Source	Gold Standard	Comments
Zhan, 2007 [17]	Medicare beneficiaries 2002 to 2004	Random	Gen Surg	Post-operative Deep Vein Thrombosis (DVT) and/or Pulmonary Embolism (PE)	20,868 hospital discharges identified as surgical patients	20,868 hospital discharges identified as surgical patients	Patient Safety Indicators	Field Defined	Full	ICD-9 CM codes	Medical record	Gold standard chart review	DVT/PE events flagged by ICD-9 CM codes were compared to those discovered by gold standard chart review. The sample studied was a random sample abstracted by the Medicare Patient Safety Monitory System.
Polancich 2006 [15]	Unknown	Unknown	Unknown	Hospital acquired decubitus ulcers	not reported	123 charts from list of patients identified through PSI as having decubitus ulcers	Patient Safety Indicators	Field Defined	Full	Administrative data, billing data, ICD-9 CM diagnosis codes, procedure codes	Medical Record	Gold Standard Chart Review	Study designed to test validity of Agency for Healthcare Reseach and Quality (AHRQ) PSIs for detecting hospital acquired decubitus ulcers. Only a sample of cases were manually reviewed.
McDonald, 2002 [16]	NA	NA	NA	Adverse events	NA	NA	Patient Safety Indicators	Field Defined	Full	Discharge summaries; ICD-9 codes	NA	NA	Technical report providing detailed coding manual, including numerator, denominator, and ICD-9 codes for defining accepted, experimental, and rejected Patient Safety Indicators (PSIs). Several of the PSIs were derived from other harm detection methods. Report summarized validity information on PSIs, when this information was available from other studies.

Multiple Detection Methods

Author, Year	Population/Years	Sampling	Specialty	Harm Type	Denominator	Numerator	Method	Method Type	Full/Partial	Data Source	Gold Standard Source	Gold Standard	Comments
Penz, 2007 [47]	Adults 99 - 12/04	Sequential	MICU, SICU and other (placement of Central Venous Catheters)	Adverse events related to central venous catheter placement	316 pt records	40 patient records: 10 very low probability records and 30 high probability	Computer algorithms and Natural Language Processing	Natural Language Processing	Partial	Text records, daily progress notes, consultation notes, nursing notes, procedure notes, operative reports, discharge summaries	Text records, daily progress notes, consultation notes, nursing notes, procedure notes, operative reports, discharge summaries	Gold standard chart review	Study compared two methods for semi-automated review of text records within the VA database using NLP (MedLEE) and a phrase matching algorithm (PMA). Reviewers instructed to use only the language of notes to determine if adverse event occurred. Methods limited by incomplete or inaccurate documentation, incomplete coding, spelling errors, sentence structure abbreviations. Time/technology intensive.
Weissman, 2007 [46]	Adults 10/1/00 to 9/30/01	Random	Acute medical and surgical	Adverse event	24,676; includes 6,841 pos. screens and 17,835 neg. screens	NA	Complications Screening Program, Patient Safety Indicators, and Bates 1995 methodology	Field Defined	Partial	Medical record; billing data; ICD-9 codes	NA	NA	Screens identified by a combination of Complications Screening Program, Patient Safety Indicators, and Bates 1995 [26] methods. Gold standard full chart review done on all positive screens and on 1990 negative screens (of 17,835 negative screens). Article focused on the relationship between adverse events and hospital workload. Compared adverse events across hospitals.

Other Automated Methodologies: Lab Signal Detection

Author, Year	Population/Years	Sampling	Specialty	Harm Type	Denominator	Numerator	Method	Method Type	Full/Partial	Data Source	Gold Standard Source	Gold Standard	Comments
Dormann, 2004 [26]	Adults 6/97 - 12/97	Sequential	Gastroenterology	Adverse drug events	474 admissions of 377 patients; 109 ADEs	474 admissions of 377 patients; 109 ADEs	Automated lab signal detection	Field Defined	Full	Demographics, history, lab findings, diagnosis, and drugs	Medical record	Gold standard chart review	Used automated lab signals (ALS) and changes in ALS to identify ADEs. Automated system used to flag potential ADEs which were then sent as an alert to physicians. Use of delta ALS (change) resulted in improvement over Dormann, 2000 methodology.

Study	Population / Dates	Sampling	Setting	Outcome	Sample 1	Sample 2	Detection Method	Definition	Ascertainment	Data Source	Comparison	Validation	Comments
Bagheri, 2000 [24]	Adults 6/97 - 10/97	Sequential	Gen med and other medical subspecialties	Adverse drug event: specifically drug induced liver injury.	147 patients (156 ALT values, 159 AP)	Unknown	Detection based on serum enzyme values	Field Defined	Partial	Medical record, lab database, pharmacy database, demographics, social history (i.e. drug/alcohol use)	Voluntary reporting	voluntary reporting and stimulated voluntary reporting	Prospective study from Tolouse, France to assess incidence/detection of drug induced biochemical liver abnormalities. Patients selected by automated computer screening of alanine aminotransferase (ALT) and alkaline phosphatas (AP) values in electronic lab database. Medical charts then reviewed to determine if this was ADE. Computerized detection compared to voluntary reporting from the same time period. Relatively easy, technologically simple method.
Dormann, 2000 [25]	Unknown	Sequential	Gen Med	Adverse drug events	379 pts	Unknown	Computer based monitoring of automatically generted lab signals and reports	Field Defined	Partial	Lab database	Voluntary reporting	Stimulated voluntary report	Automated identification of cases in a German hospital, followed by manual evaluation by clinical pharmacist and clinicians. Verified ADE matched to controls to assess costs and length of hospital stay issues.
Levy, 1999 [23]	All age groups 4/97 - 5/97	Sequential	Gen Med	Adverse drug events	199 admissions (192 patients)	199 admissions	Automated lab signal detection	Field Defined	Partial	Lab database	Lab database and clinical data	Gold standard chart review	Implementation of the pilot program described in Azaz-Livshits 1998 [19]. Computerized lab data monitored to detect ADEs using the same signals as the pilot study.
Azaz-Livshits, 1998 [22]	All age groups 4/95-5/95	Sequential	Gen Med	Adverse drug events	153 admissions	153 admissions	Automated lab signal detection	Field Defined	Partial	Lab database	Lab database and clinical data	Gold standard chart review	Pilot program to develop and assess computerized laboratory data as a detection tool for ADE in 34 bed medical ward in Jerusalem, Israel. Lab signals generated by computer, then verified by team. Limited computerized patient data at this hospital, however lab data was fully electronic. Generalizable to other institutions with limited electronic data (lab only). Cost of this system reasonable compared to costs of ADEs.
Other Automated Methodologies: ICD-9 or Billing Code Detection													
Hougland, 2006 [30]	Adults 2001 calendar year	Random and Flagged sample (from records with at least one flagged ADE code)	Unknown	Adverse drug events	3103 inpatients: 1961 random sample, 1142 flagged sample	Unknown	Automated ICD-9 code strategy	Field Defined	Full: however review of flagged charts here for study purposes	ICD-9 CM codes	Medical record	Gold standard chart review	Expert panel identified 416 ICD-9 CM codes to represent ADEs (flagged ADEs). Then chart review performed to ascertain codes' ability to detect/identify ADE.
Seeger, 1996 [29]	Unknown 7/91-6/94	Sequential	Unknown	Adverse drug events	52,695 admissions	52,695 admissions	Capture-recapture method applied to automatic surveillance via medical record coding	Field Defined	Full	ICD-9 CM codes	Voluntary reporting	Voluntary reporting	ICD-9 CM codes indicative of 7 categories of ADRs used to scan patient database at University of Illinois at Chicago Medical Center to identify ADRs (electronic sample). Capture-recapture assumed all subgroups within population have equal chance of being captured each time.
Hirschhorn, 1993 [28]	Adults 4/15/87 to 10/1/89	Sequential	Obstetrics (Women with nonrepeat, nonelective cesarean sections and perioperative prophylaxis with cefazolin or cefoxitin alone.)	Infection	2,197 women	457 records (Randomly selected from full sample)	Screen for infection based on ICD-9 codes and antibiotic exposure	Field Defined	Full	Pharmacy database and ICD-9 codes	Medical record and anesthesia records	Chart review, not otherwise specified	Tool specifically detected cases of cesarean section infection using ICD-9-CM codes and parenteral postoperative antibiotic (PPA) exposure. Performance of indicators depended on accuracy of coded discharge diagnoses and automated pharmacy records. ICD-9 and infection codes listed in the appendix.
Roos, 1985 [27]	Adults 1976	Sequential	Readmissions following hysterectomy, cholecystectomy, and prostatectomy	Surgical complications	Hyst: 387; Chol: 695; Prost: 488	Hyst: 387; Chol: 695; Prost: 488	Claims review	Field Defined	Full	ICD-9 and ICDA-8 diagnostic codes	Claims data (service use) and diagnoses. Additional information provided on about 20 cases per procedure.	2 independent physician specialists rated data; met to resolve discrepancies. Only those events with agreement were included	Computer algorithm developed on 1974 Manitoba surgical claims database, revised on 1975 data, and tested on 1976 data. Used 3 or 4 digit ICDA-8 codes in first readmission after surgery for up to a 2 year period. Focused only on readmissions following hysterectomy, cholecystectomy, prostatectomy. Appendix lists of ICD-9 and ICDA-8 codes with appropriate timeframe of reference for different complications.
Other Automated Methodologies: Other Automated Triggers													

Author, Year	Population/Date	Design	Setting	Event	Sample	Sample	Method			Data Sources	Comparator	Comparator	Comments
Ferranti, 2008 [50]	Pediatric 12/1/04-1/31/06	Sequential	PICU, Gen Med, Transitional Care	Adverse drug events	4,711 admissions (51,046 patient-service days)	4,711 admissions (51,046 patient-service days)	Automated triggers: abnormal lab values, antidote administration, drug-lab combination triggers.	Field Defined	Partial	Lab database, pharmacy database.	Voluntary reporting	Voluntary reporting	Duke University Hospital evaluation of ADE detected by computerized surveillance versus voluntary reporting system. Voluntary reporting ADE rate = 1.8 events per 1000 patient days versus 1.6 events per 1000 patient days for automated method. (No statistical difference between methods). Authors postulate the reason automated surveillance fails to outperform voluntary reporting in this specific pediatric population is that the automated triggers need to be refined and tailored to better match pediatric situations.
Bellini, 2007 [41]	Adults 2 year period. Date not stated	Sequential	MICU, SICU, Gen Med, Gen Surg	Infection	669 cases of a positive blood culture	669 cases of a positive blood culture	Unnamed system with similarities to the CDC's NISS method	Field Defined	Full	Microbiological data, administrative data (patient ID, ward, and date of admission)	Medical record	Chart review, not otherwise specified	Identified new bacteremia cases as community-acquired or nosocomial (catheter related and other origins). Lausanne, Switzerland. Automated method similar to Center for Disease Control's Nosocomial Infection Surveillance System (NISS), but differed in two ways: a) did not separate blood stream infections (BSIs) that were documented microbiologically versus clinical sepsis without microbiological documentation, b) focused on catheter related infection versus other sites, instead of excluding bacteremia related to other (non-catheter) sites. Method used data available in most health care electronic record systems.
Kilbridge, 2006 [37]	Unknown 3/1/05 - 10/31/05	Sequential	Unknown	Adverse drug events	25,177 patients at univ hospital, 8029 pts at community hosp	Unknown	Automated triggers	Field Defined	Partial	Lab database, pharmacy database, demographic data	Voluntary reporting	voluntary reporting	Comparison of ADE rates and nature between academic center and community setting using methods reported in Kilbridge, 2006 [36]. Pharmacist and physician chart reviewers.
Kilbridge, 2006 [38]	Unknown 3/05-4/05	Sequential	Unknown	Adverse drug events	6940 pts	Unknown	Automated triggers	Field Defined	Partial	Lab database, pharmacy database, demographic data	Voluntary reporting	voluntary reporting	Duke University Hospital. Detection of ADEs by automated trigger signals derived from various lab abnormalities, physician orders etc. Daily list of triggers evaluated by 2 pharmacists and weekly reviewed by physician. Automated rules derived and modified from HELP studies. Specialized resources involved, and 30 person hours per week. Programming resources considerable, perhaps not widely available.
Pokorny 2006 [39]	Adults 4/15/99-6/30/02	Sequential	ICU - general	Infection	1043 patients	194 pts in ENVIN-UCI project from 99-02 (see methods)	Computer surveillance	Field Defined	Unknown	Lab database, pharmacy database, administrative data, diagnoses data	Medical record, bedside clinical data.	Other: "bedside data collection"	Retrospective analysis comparing computer based surveillance using three nosocomial infection (NI) suspicion criteria (positive microbiology, antibiotic administration, clinical diagnosis infection) with rates of infection obtained from prospective incidence study done over the same period (ENVIN - UCI) which consisted of bedside collection of data on ICU infections. NI classified according to international definitions, onset > 48 hrs after admission.
Szekendi, 2006 [40]	Adults 6/03 to 9/03	Sequential	All units, except pediatric and NICU	Adverse event	327 medical records; 493 trigger events	NA	Automated trigger tools	Field Defined	Partial	Lab database and pharmacy database	NA	NA	Automated identification of charts with trigger tool (using 21 electronic triggers), followed by a manual review by a nurse and pharmacist (followed by additional physician review if no agreement). All records with 2 or more triggers were selected, followed by cases with triggers from medical list, abnormal lab list, and positive blood culture selected on a sequential rotating basis. Time: 35 minutes/chart not requiring physician review; 45 minutes/chart if physician review required.

Study	Population/Dates	Sampling	Setting	Event	Denominator	Numerator	Detection method	Method type	Defined	Comprehensiveness	Data source 1	Data source 2	Reference standard	Comments
Forster, 2005 [34]	Adults fiscal 2002	Random	Gen Med, Gen Surg	Adverse event	245 patients	245 patients	Computerized screen for trigger words in free text	Natural Language Processing		Partial	Discharge summaries	Discharge summaries	Gold standard chart review	Substudy of Ottawa Hospital Patient Safety study. Automated adverse event lexicon made up of 104 terms used by Murff 2003 [31]. Computerized search engine scanned discharge summaries (dtsearch desktop) and detected charts with potential harm, which were then reviewed by MD. Specificity found to be higher for nonelective admissions and discharge summaries dictated by residents and staff versus medical students. Automated detection reduced physician time by one-fifth.
Hartis, 2005 [35]	Unknown 7/02 - 12/03	Sequential	Unknown	Adverse drug event: specifically warfarin associated.	1,952 inpatient beds from 6 community hospitals	NA	Automated triggers	Field Defined		Partial	Lab database, pharmacy database	NA	NA	Automated triggers developed to detect warfarin associated ADE. Automated triggers are INR > 3.0 and pharmacy orders for Vitamin K. Pharmacist reviewed triggers monthly. Interventions made when trigger confirmed, (i.e. education and therapy change). Goal of study is to assess ADE rates pre and post interventions.
McIntosh, 2005 [36]	Unknown 2003 January	Sequential: all tracer drugs dispensed during time period	Unknown	Adverse drug events	775 tracer drugs ordered from Automatic Dispensing Units (ADU)	Unknown	Computerized data from automated dispensing units	Field Defined		Partial	other: ADU	not specified	Chart review, not otherwise specified, and voluntary reporting	Miami Veterans Affairs Medical Center study to determine if monitoring the removal of tracer drugs (such as naloxone) from ADU improves ADE reporting. Investigator reviews charts from ADU generated list. Upon removal of tracer drug, ADU prompts reply to the question "is medication ordered due to ADR/allergy". If the answer is yes, then chart reviewed to determine ADE. Automated surveillance data as reliable as answers to questions prompted by ADU - thus education of nurses and other staff is key.
Murff, 2003 [33]	Adults 1/1/00-7/00	Random (424) and sequential (all remaining admissions during study pd)	Gen Med and Medicine subspecialties	Adverse drug events, adverse events, other: diagnostic errors, operative complications, falls	Cohort 1: 424 randomly selected admissions Cohort 2: 2826 remaining admissions over study period	295 of cohort 1 and 145 of cohort 2 via complex sampling/sub sampling and manual review process (see Reference for details)	Computerized screen for trigger words in free text	Natural Language Processing (Keyword triggers within free text).		Full (goal is a fully automated system, manual review of subsamples performed for study.	Discharge summaries	Medical record (not otherwise specified)	Gold standard chart review	Brigham and Women's Hospital, using Brigham Integrated Computer system. Computerized screening tool searched free text discharge summaries for trigger words indicating possible adverse events. List of automated trigger words compiled using Harvard Medical Practice Study definitions as base. Electronic method alone versus electronic plus manual review compared for 2 cohorts. Computerized screen searches for programmed key words (not as sophisticated as natural language processing programs that "read" free text). Reviewers blinded to whether screening tool had identified the admission. Complex sampling/subsampling methods plus manual review process for each cohort.
Jha, 1998 [32]	Adults 10/94-5/95	Sequential	MICU, SICU, Gen Med, Gen Surg	Adverse drug events	21,964 patient-days	21,964 patient-days	Automated triggers	Field Defined		Partial	Medical record	Medical record	Gold standard chart review and stimulated voluntary report	Study of computer based ADE identification using modified Classen 1991 [8] (HELP) rules to create automated triggers with which the electronic record was screened. Rules modified during the study to increase PPV, and new rules created. Trained reviewer and physician were blinded to detection method. 11 person-hours per week for automated method versus 55 for chart review and 5 for voluntary reporting.
Whipple, 1994 [31]	Unknown	Sequential	Unknown	Adverse drug events - specifically Patient Controlled Anesthesia (PCA) related overdose	4669 patients who received PCA	4669 patients who received PCA	Computerized search strategy	Field Defined		Partial	Billing data, clinical admission data, transfer, discharge and death databases	Voluntary reporting	voluntary reporting	Retrospective computerized data retrieval study to identify ADE related to PCA use. First identified applicable billing codes for overdose, plus patients who had other evidence for overdose (i.e. ICU transfer etc). Charts with possible overdose then reviewed manually. Study used hospital's current computer system as they did not have funds for a new computer or computer programs, thus this technology could be generalizable.

Other Automated Methodologies: Specific Named Programs													
Seger, 2007 [45]	Adults 7/1/02 to 12/31/02	Sequential	Gen Med and Gen Surg	Adverse drug events	3,428 patients, of which 215 had high or critical alerts	56 charts; 48 unique patients	Dynamic Pharmaco-Monitoring System	Field Defined	Partial	Lab database, pharmacy database, and demographics	Medical record	Chart review, not otherwise specified	Dynamic Pharmaco-monitoring system identified critical, high, medium, and low alerts. This method focused on the critical and high alerts only. Separately identified preventable and non-preventable ADE. Provides a rough estimate of cost and time required (1.5 hours/day of pharmacist time - results in expected cost savings of $49,000 in first year).
Brossette, 2006 [44]	Unknown 12/1/03 to 12/3/03 and 4/26/04 to 4/29/04	Sequential	Unknown	Infection	907	907	Nosocomial Infection Marker (NIM)	Field Defined	Full	Multiple sources: Medical record; Lab database	Medical record	Gold standard chart review	Nosocomial Infection Marker (NIM) program by Med Mined, Birmingham, AL. Took about 10 minutes/week to maintain.Total time for NIM: 2 hours/10,000 admissions, compared to medical record review at 1.5 full time employees per 10,000 admissions)
Huang, 2005 [43]	Unknown 1/1/04-12/41/04	Sequential	Unknown	Adverse drug event: specifically hyperkalemia on spironolactone	3995 pts on spironolactone	662 pts on spironolactone sequentially from 1/1/04 - 9/30/05	Event Detector automated event detecting computer program	Field Defined	Unknown	Lab database, pharmacy database (none others specified)	Lab database, pharmacy database, none others specified	Chart review, not otherwise specified	Implementation of a new rule in an established automated event detection system (EventDetector) to monitor serum potassium in patients receiving spironolactone. Study encompassed 3 separate hospitals.
Graham, 2004 [42]	Children 1/00 - 12/02	Unknown	NICU	Infection	Unknown	Unknown	NYARP (New York Antimicrobial Resistance Project) electronic monitoring of bloodstream infections	Field Defined	Full	Microbiology data for positive blood cultures	Medical record, prospective evaluation by ICP	Other: Prospective surveillance study "Staff hand hygiene and nosocomial infections in neonates" by infection control professional (see methods)	Study designed to validate NYARP data by comparing with prospective surveillance by infection control professional (independent study over the time period march 2001 - Jan 2002.) The NYARP electronically monitors trends in nosocomial infections in 14 acute care hospitals via monitoring positive blood cultures. Not validated to other institutions or patient populations. NYARP limited to bacterial infections. Relatively low cost to maintain database.