

Summary of studies on the rates of medication errors across the medicines management system in primary care

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1	Reference	Year of study	Country	Study setting	Method of Identification	Study Design	Type of error	Definitions used for data collection	Incidence/rate reported
2	Abramson et al (2011)	2005/2006	USA	78 Community-based primary care providers across two states who used paper prescriptions	Prescription and medical record review	Non-randomised retrospective study	Prescribing	Errors in prescriptions and prescribing	36.7/100 prescriptions (95% CI 30.7-44.0), excluding illegibility errors
3	Al Khaja et al (2007)	2004	Bahrain	20 primary health care centres	Audit of paediatric prescriptions	Retrospective clinical prescription review	Prescribing	Omission (minor and major), commission (incorrect information) and integration errors (e.g. Drug interactions)	90.5% prescriptions (of 2,282 total prescriptions, excluding minor errors of omission)
4	Al Khaja et al (2005)	2003	Bahrain	18 primary health care centres	Pharmacy staff screened prescriptions for errors: audit of prescriptions	Prospective clinical prescription review	Prescribing	Omission (minor and major), commission (incorrect information) and integration errors (e.g. Drug interactions)	7.7% prescriptions (5,959/77,511 prescriptions, excluding minor errors of omission)
5	Ashcroft et al (2005)	1995	UK	35 community pharmacies	Pharmacist-led identification	Prospective study	Dispensing	Near miss' - incident that was detected up to, including the point at which medication was handed over to patient or their representative' Incidents detected after patients had taken possession of medication were recorded as 'dispensing errors'	3.99 errors/10,000 dispensed items (95% CI 2.96 - 5.26); 'near miss' - 22.33 (95% CI 19.79-25.10)
6	Avery et al (2012)	2010	UK	15 general practices from four Primary Care Trusts	Review of patient clinical or medical records, healthcare professional interviews	Randomised retrospective study	Prescribing, monitoring	Prescribing error occurs when, as a result of a prescribing decision or prescription-writing process, there is an unintentional, significant reduction in the probability of treatment being timely and effective, or increase in the risk of harm when compared to generally accepted practice; Monitoring error occurs when a prescribed medicine is not monitored in the way which would be considered acceptable in routine general practice.	Percentage of prescriptions with prescribing or monitoring errors = 4.9% (95% confidence intervals (CI) 4.4%-5.4%; n=1,200); percentage of patients with errors = 12%.
7	Barber et al (2009)	2009	UK	256 residents from 55 nursing/residential homes	Patient interview, note review, practice observation, dispensed items examination	Prospective study of random sample of residents within a purposive sample of homes	Prescribing, Dispensing, Administration Monitoring	Prescribing error - deviations from prescribing standards in decision and writing (Dean et al, 2000); Monitoring - deviations from monitoring standards (Alldred et al, 2008); Dispensing - deviations from prescriptions and orders (Beso et al, 2005); Administration - variations between prescriptions and administrations (Dean and Barber, 2001)	Prescribing - 8.3% (95% CI 7.1-9.5); Dispensing - 9.8% (95% CI 8.5-11.2); Medication administration error - 8.4% (95% CI 7.0-10.0); Monitoring - 14.7% (95% CI 10.3-20.1); all error rates are percentages of opportunity for error; mean potential harm from prescribing, monitoring, dispensing and administration errors=2.6,3.7,2.1,2.0 (0=no harm, 10=death). 69.5% residents had one or more errors; Mean number of errors per resident - 1.9 errors
8	Carruthers et al (2008)	2006	UK	2, 480 residents from 42 primary care-based Regional aged-care facilities (RACFs)	Audit of the accuracy of dose administration aids (DAA)	Prospective observation (prior to patient administration)	Dispensing	Comparison of drug charts prepared by patients' GPs with contents of DAA by registered nurses. Discrepancies were recorded as incidents	4.3% packs or 12% residents corresponding to 297 incidents in 6,972 packs. Incidents - wrong drug, strength, label and instructions.
9	Chen et al (2005)	1999/2000	UK	4 General practices with an estimate of 37, 940 patients	Review of computerised patient medical record	Retrospective review of identified potential drug-drug or drug-disease interactions	Prescribing	Potential for serious drug-drug interactions or drug-disease interactions (contraindications)	1.9 incidents/1,000 patient years (95% CI 1.5-2.3) or 4.3/1,000 patients on 2 or more medications per year (95% CI 3.2-5.4); 2 adverse drug events
10	Chua et al (2003)	2002	UK	4 conveniently-sampled community pharmacies within the Hull and East Riding Pharmacy Research Network, North of England	Review and analysis of self-recorded dispensing errors and 'near misses'	Prospective audit	Dispensing	Near miss' - dispensing error identified by pharmacy prior to patient receipt of medication; Dispensing error - recorded if error discovered following patient receipt	Dispensing error rate=0.08% items; 'Near miss' rate=0.48% items; 56/10,000 items or 0.56% items total dispensing errors or 'near miss' (95% CI 49-62)
11	Dhabali et al. (2011)	2010	Malaysia	Primary care setting of a University, Universiti Sains Malaysia (USM)	Review of data from 1 academic year using computerized databases	Retrospective study	Prescribing	Drug contra-indications	5.3% of all patients over a 1-year period or 5,339 DCIs per 100,000 patients (923 patients had drug contra-indications of 17,288 registered patients); 3.8% patients were exposed to 5 or more contra-indications
12	Field et al (2007)	2007	USA	Large multi-specialty group practice with 30,000 enrollees	Electronic tracking of administrative data; clinician reports; hospital discharge summary; emergency visit	Retrospective review of identified potential adverse events	Administration	Potential adverse drug events due to patient errors during medication use	Incidence difficult to interpret; patient errors leading to adverse events was 129 (of 1,299 patients with an adverse event in original study)
13	Flynn et al (2009)	2009	USA	100 Community chain pharmacies in large metropolitan areas of four states	Unidentified 'shoppers presented non-real life prescriptions	Retrospective observation of dispensed items	Dispensing	Variation between prescription and dispensed item (accuracy of dispensing)	22% (% errors of total prescriptions presented; n=100)

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14	Gagne et al (2008)	2008	Italy	Outpatient prescriptions of residents in Regione Emilia-Romagna, Italy	Review of all outpatient prescription claims in 2004 in the region	Retrospective review of claims data	Prescribing	Drug interactions - presence of minimum of 5-day overlap in days supply for drugs in an interacting pair	211/100,000 items prescribed (0.2%); 8894 potential drug interactions detected
15	Gandhi et al (2003)	2003	USA	1,202 patients at four adult primary care practices in Boston, USA	Patient survey, chart review	Prospective cohort study	Prescribing, Administration, Monitoring (adverse drug reactions from errors)	Preventable adverse drug events - due to error which could have been avoided; ameliorable - those whose severity or duration could have been reduced	Adverse drug event rate = 25% patients or 27% events (of 661 patients responding to survey); 11% and 28% events were preventable and ameliorable respectively, therefore medication error rate = 39.2% (i.e. (51+20)/100x181)
16	Gandhi et al (2005)	2003	USA	1,879 prescriptions of 1,202 patients at four adult primary care practices in Boston, USA	Prescription review, patient survey, chart review	Prospective cohort study	Prescribing	A medication error - any error that occurred in the medication use process. The subset of these errors related to prescribing errors. Errors causing injury were preventable; those with potential to cause injury were potential ADEs	7.6% prescriptions (95% confidence interval (CI) 6.4% to 8.8%) contained a prescribing error; 3% prescriptions had potential for patient injury, 1% was life-threatening; 24% were serious; frequency and dosing errors most common
17	Gurwitz et al 2003	1999/2000	USA	Medicare enrollees (30 397 person-years of observation) in a multispecialty group practice >65 years	Review of provider reports, discharge summaries, emergency department notes, computer-generated signals, electronic clinic notes, incident reports	Retrospective cohort study	Prescribing, monitoring, administration	Adverse drug event - injury resulting from system of drug use; adverse drug event resulting from medication error was defined as preventable adverse drug event	13.8 preventable adverse drug events per 1000 person-years or 27.6% of 1,523 total adverse drug events; of these, prescribing errors = 16.2%, monitoring = 16.8%, administration = 5.8% (all of total events)
18	Hammerlein et al (2007)	2005	Germany	Nation-wide study in 1,146 community pharmacies in Germany	Community pharmacies recorded identified Drug-related problems (DRPs) during any 1 week period per pharmacy within designated study period	Prospective study	Prescribing, administration ('patient level'), dispensing ('delivery level')	A drug-related problem (DRP) - an event or circumstance that actually or potentially interferes with desired health outcomes with potential for ineffective pharmacotherapy and/or drug-related morbidity and mortality.	Rate was difficult to interpret; 10,427 DRPs identified representing 9.1 DRP per pharmacy per week; drug-drug interactions most common
19	Kaushal et al (2010)	2002/2003	USA	1,782 patients from six paediatric (<21 years) outpatient practice	Prescription review, telephone survey, chart review	Prospective cohort study	Prescribing, transcribing, administration, monitoring	Medication errors - errors in medication ordering, transcribing, dispensing administration and monitoring, with minimal potential for harm and near misses; Preventable ADE were medication errors that caused harm	Medication errors rate = 74% prescriptions or 93.7% patients; 68% patients (53% prescriptions) had minimal potential for error; 26% patients (21% prescriptions) had potential for harm ('near misses'). Most errors were at prescribing stage
20	Kaushal et al (2007)	2002/2003	USA	1,788 patients from six paediatric (<21 years) outpatient practice	Prescription review, telephone survey, chart review	Prospective cohort study	Prescribing, transcribing, administration, monitoring	Medication errors - errors in medication ordering, transcribing, dispensing administration and monitoring, with minimal potential for harm and near misses; Preventable ADE were medication errors that caused harm	Preventable ADEs = 3% patients; administration errors = 2.24% patients; prescribing/ordering = 26% errors; dispensing errors = 3% errors
21	Khoja et al (2011)	2002	Saudi Arabia	10 public and private (5 each) primary health care clinics in Riyadh City	Review of a simple random selection of patient clinical management records (case notes); all prescriptions issued on study day	Retrospective audit	Prescribing	Prescription error - any preventable event that may cause or lead to inappropriate medication or patient harm when medication is in control of the healthcare professional, patient or consumer	Prescribing error=18.7% prescription items (990/5299 items); Type A or potentially serious error rate=0.15% items (8/5299 items)
22	Knudsen et al (2007)	2004	Denmark	40 randomly-selected Danish community pharmacies	Review of documented self-reported incidents by community pharmacies and a web-based incident reports of ADEs	Prospective and retrospective studies	Prescribing, dispensing, transcribing	Prescribing error - administrative/clinical prescription interventions by pharmacy; dispensing error - errors in dispensing that reached the patient; 'near miss' - internal pharmacy error detected prior to patient collection; transcription - pharmacy transfer of data from prescription to label	Prescribing error=23.1/10,000 prescriptions; dispensing error=1.4/10,000 prescriptions; 'near miss'=2.4/10,000 prescriptions; total transcription error - 64.9% of total dispensing errors
23	Kuo et al (2008)	2000/2003	USA	52 family practices in rural, urban and suburban comprising private, training clinics and community health centres	Analysis of data from two error-reporting systems (web- and paper-based)	Retrospective study	Prescribing, dispensing, monitoring, administration, documentation?	Medication error - things that happened in the practice that should not have happened, which staff were willing to prevent and those that did not happen but should have (as they related to medication)	Medication error rate=14% of total medical errors (of 1,265 total errors); Of these, Prescribing errors=70%, Documentation error=10%, Dispensing errors=7%, Administration errors=10%, Monitoring errors=3%
24	Lasser et al (2006)	2002	USA	51 ambulatory practices in greater Boston area	Electronic health record (EHR) review of patients >18 years who received a prescription for a drug containing a 'black box' warning (as defined) during 1 year	Retrospective study	Prescribing, monitoring	Prescribing error - drug-drug interactions and drug-disease interactions with little or no potential for harm; Monitoring error - drug-laboratory monitoring interactions with little or no potential for harm (violations of the 'black box' or labelling warnings in Physicians' Desk Reference, PDR)	2,354 patients of 33, 778 received prescription in violation of warning i.e. 70% of patients prescribed at least one medication containing warning OR 0.7% of all patients receiving prescription medication. <1% of patients had an ADE as a result of such violations. 1 in 4 patients (25% patients) who had received drug in violation of warning had a medication error

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25	Lynskey et al (2007)	2004	UK	15 community pharmacies within Brighton and Hove Primary Care Trust (PCT), East Sussex	Pharmacist-detected problems (errors) as reported during a 10-week data collection period	Prospective study	Prescribing, dispensing, administration	An incident' was as any preventable event that may lead to or cause inappropriate use or patient harm. 'Near miss' was any incident up to and including the point at which the medication left the pharmacy. Actual errors were error discovered once the medication had left the pharmacy following dispensing	Near miss' prescribing and dispensing error rates of 15.9% and 62.1% of total errors (n=23 and 90 of 145 errors reported respectively); 'Actual prescribing, dispensing, and administration error rates of 2.1%, 19.3% and 0.7% of total errors (n=3, 28 and 1 of 145 errors reported) respectively
26	Martinez Sanchez and Campos (2011)	2009	Spain	1 community pharmacy	Pharmacist-detected problems (errors) reported during a 6-month data collection period	Prospective study	Prescribing, Transcribing	Prescribing errors - any error identified in the process of dispensing to interfere with initial dispensing, e.g. incomplete prescriptions/ incorrect information; or potentially harmful to patients, e.g. potentially hazardous drug-drug interactions, inappropriate doses or directions, contraindications, ADRs, allergies, and duplications	Prescribing error rate = 1.5% of total prescriptions (355 errors detected of 23,995); transcription error rate = 0.44% of total prescriptions
27	Marwaha et al (2010)	2010	India	Handwritten prescriptions from seven general practice physicians presented to community pharmacies	Retrospective review of hand-written prescriptions presented to community pharmacies during a 2-month period	Retrospective study	Prescribing	An error is defined as the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim. Prescription errors - defined as either an error in writing the prescription, or in the prescribing decision, which may impair effectiveness of treatment administration or have potential for harming a patient	196 errors from 3151 prescribed items collected giving an error rate of 6.09 per 100 items (95% CI 5.78-6.41). Most common errors related to directions with an error rate of 2.8 per 100 items (95% CI 2.6-3)
28	Nanji et al (2011)	2008	USA	Outpatient computer-generated prescriptions across three states	Retrospective review of computer-generated prescriptions received by commercial outpatient pharmacies in three states over 4 weeks	Retrospective cohort study	Prescribing	Prescriptions errors - corrections on prescriptions that required active interventions by pharmacists	Prescribing error rate = 11.7% of prescriptions, of which 35% had potential for harm. (1 in 10 computer-generated prescriptions included at least one error, of which one-third had potential for harm) Error rates varied by computerized prescribing system, from 5.1% to 37.5% (denominator uncertain)
29	Runciman et al (2003)	2003	Australia	Representative samples of general practices, and community pharmacies patient records	Retrospective review of national data achieves on 1,000 GP with 100,000 annual consultations and 1,000 high-risk patients from pharmacists' case notes over a 1 year period	Retrospective audit	Prescribing	Medication incident - an event or circumstance associated with medication use that could have, or did lead to unintended and/or unnecessary harm to a person.	Adverse event rate = 0.89% of 'encounters' (or prescriber contact) in 1999-2000; of these, 43% were ADR (i.e. Not solely due to medication errors). Medication error rate was not reported, and was difficult to calculate
30	Sayers et al (2009)	2009	Ireland	28 general practitioners and 12 community pharmacies	Prospective survey of prescriptions presented to community pharmacies over a 3-day period	Prospective study	Prescribing	Prescription errors detected by community pharmacies requiring intervention prior to dispensing	Prescribing error rate = 12.4% prescriptions (491 of 3,948) or 6.2% items (546 of 8,686); 2.4% errors were serious
31	Shah et al (2001)	2001	UK	3 community pharmacies and 3 general practices located near the pharmacies	Retrospective analysis prescriptions from 23 doctors (three general practices) presented to three community pharmacies over the course of two months	Retrospective study	Prescribing	Prescription errors detected by community pharmacies requiring pharmacist intervention prior to dispensing including administrative and legal errors (excluding medicines usually used 'as directed' and for unlicensed indications)	Prescribing error rate of 7.46 per 100 items (95% CI 7.2-7.8); Errors were found on 140 of the 1,373 handwritten items presented during the study period (10.2%) compared with 1,233 of the 33,772 computer-generated items (7.9%) (chi-square 15.65, df = 1, P<0.0001)
32	O'Grady and Dean Franklin (2007)	2007	UK	11 community pharmacies	Direct observation of dispensed items awaiting receipt by or delivery to patient	Prospective study	Dispensing, Transcribing	Any unintended deviation from an interpretable written prescription or medication order. Both content and labelling errors were included. Any unintended deviation from professional or regulatory references, or guidelines affecting dispensing procedures, was also considered a dispensing error	Content error rate = 1.7%; Labelling error rate = 1.6% (dispensed items)
33	Szczepura et al (2011)	2009/2010	UK	A cohort of 345 older residents in 13 care homes (9 residential, 4 nursing)	Disguised observation technique using pharmacy-managed barcode medication administration system, BCMA	Prospective study	Administration	Any deviation between medication as prescribed and that administered	Medication administration error rate=1.2% of total barcode medication administration episodes; 90% residents were exposed to MAE during the 3-month study period; each resident was exposed to 6.6 potential MAE
34	Warholak et al (2009)	2006	US	Outpatient computer-generated prescriptions (e-prescriptions) in five states	Participating pharmacists documented active interventions on e-prescriptions	Prospective study	Prescribing	Prescriptions errors - corrections on prescriptions that required active interventions by pharmacists	Error rate = 3.8% prescriptions (102 interventions of 2,690 e-prescriptions)

