Safety of medication use in primary care
Janice O. Olaniyan, Maisoon Ghaleb, Soraya Dhillon and Paul Robinson

Abstract
Background Medication errors are one of the leading causes of harm in health care. Review and analysis of errors have often emphasized their preventable nature and potential for reoccurrence. Of the few error studies conducted in primary care to date, most have focused on evaluating individual parts of the medicines management system. Studying individual parts of the system does not provide a complete perspective and may further weaken the evidence and undermine interventions.

Aim and Objectives The aim of this review is to estimate the scale of medication errors as a problem across the medicines management system in primary care. Objectives were:
1. To review studies addressing the rates of medication errors, and
2. To identify studies on interventions to prevent medication errors in primary care.

Methods A systematic search of the literature was performed in PubMed (MEDLINE), International Pharmaceutical Abstracts (IPA), Embase, PsycINFO, PASCAL, Science Direct, Scopus, Web of Knowledge, and CINAHL PLUS from 1999 to November, 2012. Bibliographies of relevant publications were searched for additional studies.

Key findings Thirty-three studies estimating the incidence of medication errors and thirty-six studies evaluating the impact of error-prevention interventions in primary care were reviewed. This review demonstrated that medication errors are common, with error rates between <1% and >90%, depending on the part of the system studied, and the definitions and methods used. The prescribing stage is the most susceptible, and that the elderly (over 65 years), and children (under 18 years) are more likely to experience significant errors. Individual interventions demonstrated marginal improvements in medication safety when implemented on their own.

Conclusion Targeting the more susceptible population groups and the most dangerous aspects of the system may be a more effective approach to error management and prevention. Co-implementation of existing interventions at points within the system may offer time- and cost-effective options to improving medication safety in primary care.

Introduction
Medical error and patient safety have been the subjects of discussions for government bodies, healthcare organizations, the media, researchers and patients in the past decade. The American Institute of Medicine report, ’To err is human,’ describes the harmful, common, expensive and, importantly, the preventable nature of medical errors.[1] A UK Department of Health report, ‘An organization with a memory: learning from adverse events in the NHS (National Health Service),’[2] emphasises the importance of learning from errors based on their potential for reoccurrence. These government reports underscore the need for a paradigm shift in safety culture within healthcare teams and organisa-
Medication errors are one of the most common types of medical errors resulting in patient morbidity and mortality. Much of the research conducted on medication safety has focused on the secondary care setting because of its associated high-risk procedures such as blood transfusion, surgery and the potential for hospital-acquired infections. However, a few studies have indicated that patient safety incidents in hospitals take their roots from primary care management.

The medicines management process differs between secondary and primary care owing to variations in practitioner, patient and process features with implications for error potential. For example, in secondary care, there is close co-working among healthcare professionals – doctors, nurses and pharmacists – and medication administrations and reviews occur in collaboration. In primary care, however, patients come into contact with these healthcare professionals at different times and places, and mostly self-administer their own medicines. Patients may frequent multiple pharmacies in primary care presenting challenges for medicines reconciliation. Medication monitoring in primary care is further complicated by relying on the patient to organise and book follow-up appointments. A World Health Organization body, World Alliance for Patient Safety, concludes that inadequate or inappropriate communication and coordination are major priorities for patient safety research in developed countries.

Medication error studies evaluate whether a medicine is correctly handled within the medicines management system, which comprises of prescribing, transcribing, dispensing, administration and monitoring stages. An Adverse Drug Event (ADE) is said to occur when patient harm is caused by the use of medication – a preventable ADE therefore may occur as a result of a medication error at any stage of the medicines management system. The specific rates of medication errors (and preventable ADEs) are unknown as most errors in medication go unnoticed. Of those identified, few result in patient harm. For instance, of a prescribing error rate of 1.5% detected in 36 200 medication orders in a UK hospital, only 0.4% orders contained a serious error. In a recent UK primary care study, 4.9% prescriptions contained a prescribing or monitoring error when the medical records of 1200 patients from 15 general practices were reviewed, of these, one in 550 (or 0.18%) of all prescriptions was judged to contain a severe error. In a UK study of 55 care homes, although 69.5% of all residents had one or more errors, the mean potential harm from errors in prescribing, monitoring, administration and dispensing were 2.6, 3.7, 2.1 and 2.0 (0 = no harm; 10 = death) respectively. These seemingly ‘low’ values of actual harm are better understood when interpreted in terms of the high volumes of prescriptions issued daily within any healthcare system. Even more so, associated patient morbidity and mortality is simply unquantifiable.

The preventable nature of medication errors, and the potential for reoccurrence are perhaps their most important characteristics. These attributes underpin medication safety concepts such as error reporting and learning, and the development and implementation of prevention strategies, as errors are often the results of the systems that produce them. A few studies have estimated the preventability of medication errors in primary care. In the UK, approximately 5% admissions to secondary care have taken their roots from preventable drug-related problems at an estimated cost of over £750 million per year to the NHS. A healthcare system, with safety and quality at its heart, is therefore expected to capture errors, and most importantly, prevent reoccurrence.

System thinking has underpinned successful investigations into suboptimal patient care – the events of the Bristol Royal Infirmary in the UK sparked an investigation, which focused on evaluations of the system rather than the events in isolation. Most error studies, however, focus on individual points within the medicines management system, instead of adopting critical and holistic evaluations of the whole system of the use of medicines. Similarly, interventions have often concentrated on improving individual parts of the system. For instance, automation in hospital pharmacies has aimed at improving the dispensing process, even though other parts of the system may also benefit from some form of automation. This individualistic approach fails to recognise that errors are indeed the results of the systems that produce them and does not provide information on the relationship between the units that make up the system.

To date, there have been few systematic reviews to appraise the safety of the entire medication use system in primary care across healthcare systems.

Aim of review

This paper reviewed the existing literature on the incidence of medication errors in primary care across the entire medicines management system. The objectives were:

1. To appraise studies addressing medication error rates in primary care:
   a. To report error rates at each point of the system
   b. To appraise the methods used to identify errors in the studies
   c. To identify of the most susceptible points and patient groups
d. To compare error rates between healthcare settings,
and
2. To identify studies on interventions to prevent medication
errors in primary care.

Methods

Data sources
Electronic databases of MEDLINE, International Pharmaceu-
tical Abstracts, Embase, PsycINFO, PASCAL (searched
together on Wolters Kluwer/OVID SP platform in the British
Library (BL)), Science Direct, Scopus, Web of Knowledge and
CINAHL PLUS were searched. The choice of databases was
based on the BL resources in Medicine and Healthcare, Uni-
versity of Hertfordshire Medicines-related database recom-
mendations, and relevant publications. Reference lists of
retrieved articles and relevant review articles were checked
manually for further relevant studies.

Search terms and strategy
An initial scoping review retrieved 2530 hits after removal of
450 duplicates. Following screening of the first 350, over 200
articles were secondary care-related studies; subsequently, a
revised search strategy excluded secondary care terms.
Furthermore, the term ‘adverse drug event’ was used as a
medication error search term. This returned over 10 000
additional results. The first 300 articles were related to the
harm due to drug use. However, this review aimed to identify
failures in the medication use process in order to provide an
overview of the overall reliability, efficiency and safety.

The search strategy, tailored for each database, therefore
included two concepts, medication error and primary care,
and excluded a third, secondary care (Table 1). ‘Medication
error’ was used as MeSH term and keyword. A hand search of
key journals, which included International Journal of Phar-
macy Practice (IJPP), Quality and Safety in Healthcare and
Pharmacy World and Science, was also performed.

Selection criteria
Studies conducted in any country between January 1999 and
November 2012 and reported in English were included.
Studies, which reported the frequency of errors in the medi-
cines management process, and interventions to prevent
errors, were included. All definitions of error such as inap-
propriate prescribing; prescribing, dispensing, administra-
tion and monitoring errors; irrational drug use; hazardous
prescribing; and drug interactions were included. Studies
estimating error rates of one medication or therapeutic
group, and those that did not report the method used for
collecting error data or evaluating interventions, were
excluded.

The first author (JOO) screened all titles and abstracts to
determine whether the article met the inclusion criteria and
should be retrieved. Another reviewer (MG) screened a
random 5% sample to check the reliability of the screening.
JOO then read and extracted data from the articles included
in this review.

Process of data extraction
Search results were exported to Endnote X5 (Thomson
Reuters, Times Square, New York, NY, USA). Duplicates were
removed. Article titles and abstracts were initially reviewed
for relevance followed by actual article review to clarify any
ambiguities. Information from incidence studies was
extracted onto a pro-forma showing primary author, year of
publication, study design and setting, sample size, error type,
error definitions and reported error rates (Table 2a). Inter-
vention studies were grouped into broad categories (Table 3).

Results
The output of the search process is shown in Figure 1. Thirty-
two studies, which estimated the incidence of medication
errors in primary care, were identified; a manual search
retrieved one additional study. Thus, 33 studies were iden-
tified and reviewed (Table 2b).
<table>
<thead>
<tr>
<th>Reference</th>
<th>Year of study</th>
<th>Country</th>
<th>Study setting</th>
<th>Method of Identification</th>
<th>Study Design</th>
<th>Type of error</th>
<th>Definitions used for data collection</th>
<th>Incidence/rate reported</th>
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<tbody>
<tr>
<td>Abramson et al.</td>
<td>2005/2006</td>
<td>USA</td>
<td>78 Community-based primary care providers across two states who used paper prescriptions</td>
<td>Prescription and medical record review</td>
<td>Non-randomised retrospective study</td>
<td>Prescribing Errors in prescriptions and prescribing</td>
<td>Errors in prescriptions and prescribing</td>
<td>36.7/100 prescriptions (95% CI 30.7–44.0), excluding illegibility errors</td>
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<td>Al Khaja et al.</td>
<td>2004</td>
<td>Bahrain</td>
<td>20 primary healthcare centres</td>
<td>Audit of paediatric prescriptions</td>
<td>Retrospective clinical prescription review</td>
<td>Prescribing</td>
<td>Omission (minor and major), commission (incorrect information) and integration errors (e.g. Drug interactions)</td>
<td>90.5% prescriptions of 2282 total prescriptions, excluding minor errors of omission</td>
</tr>
<tr>
<td>Al Khaja et al.</td>
<td>2003</td>
<td>Bahrain</td>
<td>18 primary healthcare centres</td>
<td>Pharmacy staff screened prescriptions for errors: audit of prescriptions</td>
<td>Prospective clinical prescription review</td>
<td>Prescribing</td>
<td>Omission (minor and major), commission (incorrect information) and integration errors (e.g. Drug interactions)</td>
<td>7.7% prescriptions of 59,977 511 prescriptions, excluding minor errors of omission</td>
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<td>Ashcroft et al.</td>
<td>1995</td>
<td>UK</td>
<td>35 community pharmacies</td>
<td>Pharmacist-led identification</td>
<td>Prospective study</td>
<td>Dispensing</td>
<td>Prescribing or monitoring Errors are defined as 'dispensing errors'</td>
<td>3.99 errors/10,000 dispensed items (95% CI 2.96–5.26); ‘near miss’ 22.33 (95% CI 19.79–25.10)</td>
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<tr>
<td>Avery et al.</td>
<td>2010</td>
<td>UK</td>
<td>15 general practices from four Primary Care Trusts</td>
<td>Review of patient clinical or medical records, healthcare professional interviews</td>
<td>Randomised retrospective study</td>
<td>Prescribing, monitoring</td>
<td>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.</td>
<td>Percentage of prescriptions with prescribing or monitoring errors = 4.9% (95% confidence intervals (CI) 4.4–5.4%; n = 1200); percentage of patients with errors = 12%</td>
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<td>Barber et al.</td>
<td>2009</td>
<td>UK</td>
<td>256 residents from 55 nursing/residential homes</td>
<td>Patient interview, note review, practice observation, dispensed items examination</td>
<td>Prospective study</td>
<td>Prescribing, dispensing, administration monitoring</td>
<td>Prescribing error - deviations from prescribing standards in decision and writing (Dean et al.); Monitoring - deviations from monitoring standards (Alldred et al.); Dispensing - deviations from prescriptions and orders (Beso et al., 2005); Administration - variations between prescriptions and administrations (Dean and Barber, 2001)</td>
<td>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</td>
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<tr>
<td>Authors</td>
<td>Year</td>
<td>Country</td>
<td>Study Population</td>
<td>Study Design</td>
<td>Drug-Related Errors</td>
<td>Findings</td>
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<td>Carruthers <em>et al.</em></td>
<td>2006</td>
<td>UK</td>
<td>2480 residents from 42 primary care-based regional aged-care facilities (RACFs)</td>
<td>Audit of the accuracy of dose administration aids (DAA)</td>
<td>Prospective observation (prior to patient administration)</td>
<td>Dispensing</td>
<td>Comparison of drug charts prepared by patients’ GPs with contents of DAA by registered nurses. Discrepancies were recorded as incidents</td>
<td>4.3% packs or 12% residents corresponding to 297 incidents in 6972 packs: incidents - wrong drug, strength, label and instructions</td>
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<tr>
<td>Chen <em>et al.</em></td>
<td>1999/2000</td>
<td>UK</td>
<td>4 General practices with an estimate of 37 940 patients</td>
<td>Review of computerised patient medical record</td>
<td>Retrospective review of identified potential drug-drug or drug-disease interactions</td>
<td>Prescribing</td>
<td>Potential for serious drug-drug interactions or drug-disease interactions (contraindications)</td>
<td>1.9 incidents/1000 patient years (95% CI 1.5–2.3) or 4.3/1000 patients on 2 or more medications per year (95% CI 3.2–5.4); 2 adverse drug events</td>
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<tr>
<td>Chua <em>et al.</em></td>
<td>2002</td>
<td>UK</td>
<td>4 conveniently sampled community pharmacies within the Hull and East Riding Pharmacy Research Network, North of England</td>
<td>Review and analysis of self-recorded dispensing errors and ‘near misses’</td>
<td>Prospective audit</td>
<td>Dispensing</td>
<td>Near miss - dispensing error identified by pharmacy prior to patient receipt of medication; Dispensing error - recorded if error discovered following patient receipt</td>
<td>Dispensing error rate = 0.08% items; ‘Near miss’ rate = 0.48% items; 561/10 000 items or 0.56% items total dispensing errors or ‘near miss’ (95% CI 0.40–0.62)</td>
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<tr>
<td>Dhabali <em>et al.</em></td>
<td>2010</td>
<td>Malaysia</td>
<td>Primary care setting of a University, Universiti Sains Malaysia (USM)</td>
<td>Review of data from an academic year using computerized databases</td>
<td>Retrospective study</td>
<td>Prescribing</td>
<td>Drug contraindications</td>
<td>5.3% of all patients over a 1-year period or 5339 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</td>
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<td>Field <em>et al.</em></td>
<td>2007</td>
<td>USA</td>
<td>Large multi-specialty group practice with 30 000 enrolers</td>
<td>Electronic tracking of administrative data, clinician reports, hospital discharge summary, emergency visit</td>
<td>Retrospective review of identified potential adverse events</td>
<td>Administration</td>
<td>Potential adverse drug events due to patient errors during medication use</td>
<td>Incidence difficult to interpret; patient errors leading to adverse events was 129 (of 1 299 patients with an adverse event in original study)</td>
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<td>Flynn <em>et al.</em></td>
<td>2009</td>
<td>USA</td>
<td>100 Community chain pharmacies in large metropolitan area of four states</td>
<td>Underidentified shoppers presented non-real life prescriptions</td>
<td>Retrospective observation of dispensed items</td>
<td>Dispensing</td>
<td>Variation between prescription and dispensed item (accuracy of dispensing)</td>
<td>2.2% (% errors of total prescriptions presented; n = 100)</td>
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<td>Gagne <em>et al.</em></td>
<td>2008</td>
<td>Italy</td>
<td>Outpatient prescriptions of residents in Regione Emilia-Romagna, Italy</td>
<td>Review of all outpatient prescription claims in 2004 in the region</td>
<td>Retrospective review of claims data</td>
<td>Prescribing</td>
<td>Drug interactions - presence of minimum of 5-day overlap in days supply for drugs in an interacting pair</td>
<td>211/10 000 items prescribed (0.2%); 8804 potential drug interactions detected</td>
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<tr>
<td>Gandhi <em>et al.</em></td>
<td>2003</td>
<td>USA</td>
<td>1202 patients at four adult primary care practices in Boston, USA</td>
<td>Patient survey, chart review</td>
<td>Prospective cohort study</td>
<td>Prescribing, Administration, Monitoring (adverse drug reactions from errors)</td>
<td>Preventable adverse drug events – due to error which could have been avoided; ameliorable – those whose severity or duration could have been reduced</td>
<td>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)/100 × 181)</td>
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<td>Reference</td>
<td>Year of study</td>
<td>Country</td>
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<td>Gandhi et al [12]</td>
<td>2003</td>
<td>USA</td>
<td>1879 prescriptions of 1202 patients at four adult primary care practices in Boston, USA</td>
<td>Prescription review, patient survey, chart review</td>
<td>Prospective cohort study</td>
<td>Prescribing</td>
<td>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.</td>
<td>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.</td>
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<td>Gurwitz et al [24]</td>
<td>1999/2000</td>
<td>USA</td>
<td>Medicare enrollees (30,397 person-years of observation) in a multispecialty group practice &gt;65 years</td>
<td>Review of provider reports, discharge summaries, emergency department notes, computer-generated signals, electronic clinic notes, incident reports</td>
<td>Retrospective cohort study</td>
<td>Prescribing, monitoring, administration</td>
<td>Adverse drug event – injury resulting from system of drug use; adverse drug event resulting from medication error was defined as preventable adverse drug event.</td>
<td>13.8 preventable adverse drug events per 1000 person-years or 2.76% of 1523 total adverse drug events; of these, prescribing errors = 16.2%, monitoring = 16.8%, administration = 5.8% (all of total events).</td>
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<tr>
<td>Hammerlein et al [47]</td>
<td>2005</td>
<td>Germany</td>
<td>Nationwide study in 1146 community pharmacies in Germany</td>
<td>Community pharmacies recorded identified drug-related problems (DRPs) during any 1 week period per pharmacy within designated study period</td>
<td>Prospective study</td>
<td>Prescribing, administration ('patient level'), dispensing ('delivery level')</td>
<td>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.</td>
<td>Rate was difficult to interpret; 10 427 DRPs identified representing 9.1 DRP per pharmacy per week; drug-drug interactions most common.</td>
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<tr>
<td>Kaushal et al [48]</td>
<td>2002/2003</td>
<td>USA</td>
<td>1782 patients from six paediatric (&lt;21 years) outpatient practice</td>
<td>Prescription review, telephone survey, chart review</td>
<td>Prospective cohort study</td>
<td>Prescribing, transcribing, administration, monitoring</td>
<td>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.</td>
<td>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.</td>
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<tr>
<td>Kaushal et al [49]</td>
<td>2002/2003</td>
<td>USA</td>
<td>1788 patients from six paediatric (&lt;21 years) outpatient practice</td>
<td>Prescription review, telephone survey, chart review</td>
<td>Prospective cohort study</td>
<td>Prescribing, transcribing, administration, monitoring</td>
<td>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.</td>
<td>Preventable ADES = 3% patients; administration errors = 2.24% patients; prescribing ordering = 26% errors; dispensing errors = 3% errors.</td>
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<tr>
<td>Khoja et al [49]</td>
<td>2002</td>
<td>Saudi Arabia</td>
<td>10 public and private (5 each) primary healthcare clinics in Riyadh City</td>
<td>Review of a simple random selection of patient clinical management records (case notes); all prescriptions issued on study day</td>
<td>Retrospective audit</td>
<td>Prescribing</td>
<td>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.</td>
<td>Prescribing error = 18.7% prescription items (990/5299 items); Type A or potentially serious error rate = 0.15% items (85299 items)</td>
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<tr>
<td>Study</td>
<td>Country</td>
<td>Population</td>
<td>Methodology</td>
<td>Outcomes</td>
<td>Medication Error Rate</td>
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<td>Knudsen et al. [26]</td>
<td>Denmark</td>
<td>40 randomly selected Danish community pharmacies</td>
<td>Review of documented self-reported incidents by community pharmacies and a web-based incident reports of ADEs</td>
<td>Prescribing, dispensing, transcribing</td>
<td>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</td>
<td>Prescribing error = 23,110/10,000 prescriptions; dispensing error = 1,410/10,000 prescriptions; ‘near miss’ = 2,410/10,000 prescriptions; total transcription error – 64.9% of total dispensing errors</td>
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<td>Ku et al. [27]</td>
<td>USA</td>
<td>52 family practices in rural, urban and suburban comprising private, training clinics and community health centres</td>
<td>Analysis of data from two error-reporting systems (web- and paper-based)</td>
<td>Prescribing, dispensing, monitoring, administration, documentation?</td>
<td>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)</td>
<td>Medication error rate = 14% of total medical errors (of 1265 total errors); Of these, Prescribing errors = 70%; Documentation error = 10%; Dispensing errors = 7%; Administration errors = 10%; Monitoring errors = 3%</td>
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<td>Lasser et al. [30]</td>
<td>USA</td>
<td>51 ambulatory practices in greater Boston area</td>
<td>Electronic health record (EHR) review of patients &gt;18 years who received a prescription for a drug containing a ‘black box’ warning (as defined) during 1 year</td>
<td>Prescribing, dispensing, monitoring</td>
<td>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; ‘near miss’ – 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; ‘actual’ rate of ADEs</td>
<td>2354 patients of 33,778 received prescription in violation of warning i.e. 70% of patients prescribed at least one medication containing a ‘black box’ warning OR 0.7% of all patients receiving prescription medication. &lt;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</td>
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<td>Lynskey et al. [32]</td>
<td>UK</td>
<td>15 community pharmacies within Brighton and Hove Primary Care Trust (PCT), East Sussex</td>
<td>Pharmacist-detected problems (errors) as reported during a 10-week data collection period</td>
<td>Prescribing, dispensing, administration</td>
<td>An incident was 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</td>
<td>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%, 19.9% and 0.7% of total errors (n = 3, 28 and 1 of 145 errors reported), respectively</td>
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<td>Martinez Sanchez and Campos [29]</td>
<td>Spain</td>
<td>1 community pharmacy</td>
<td>Pharmacist-detected problems (errors) reported during a 6-month data collection period</td>
<td>Prescribing, dispensing, transcribing</td>
<td>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</td>
<td>Prescribing error rate = 1.5% of total prescriptions (355 errors detected of 23,995); Transcription error rate = 0.44% of total prescriptions</td>
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<tr>
<td>Reference</td>
<td>Year of study</td>
<td>Country</td>
<td>Study setting</td>
<td>Method of Identification</td>
<td>Study Design</td>
<td>Type of error</td>
<td>Definitions used for data collection</td>
<td>Incidence/rate reported</td>
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<tr>
<td>Marwaha et al.[51]</td>
<td>2010</td>
<td>India</td>
<td>Handwritten prescriptions from seven general practice physicians presented to community pharmacies</td>
<td>Retrospective review of hand-written prescriptions presented to community pharmacies during a 2-month period</td>
<td>Retrospective study</td>
<td>Prescribing</td>
<td>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</td>
<td>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)</td>
</tr>
<tr>
<td>Nanji et al.[52]</td>
<td>2008</td>
<td>USA</td>
<td>Outpatient computer-generated prescriptions across three states</td>
<td>Retrospective review of computer-generated prescriptions received by commercial outpatient pharmacies in three states over 4 weeks</td>
<td>Retrospective cohort study</td>
<td>Prescribing</td>
<td>Prescriptions errors -- corrections on prescriptions that required active interventions by pharmacists</td>
<td>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 27.5% (denominator uncertain)</td>
</tr>
<tr>
<td>Runciman et al.[53]</td>
<td>2003</td>
<td>Australia</td>
<td>Representative samples of general practices and community pharmacies patient records</td>
<td>Retrospective review of national data archives on 1000 GP with 100 000 annual consultations and 1000 high-risk patients from pharmacists’ case notes over a 1-year period</td>
<td>Retrospective audit</td>
<td>Prescribing</td>
<td>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.</td>
<td>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</td>
</tr>
<tr>
<td>Sayes et al.[54]</td>
<td>2009</td>
<td>Ireland</td>
<td>28 general practitioners and 12 community pharmacies</td>
<td>Prospective survey of prescriptions presented to community pharmacies over a 3-day period</td>
<td>Prospective study</td>
<td>Prescribing</td>
<td>Prescription errors detected by community pharmacies requiring intervention prior to dispensing</td>
<td>Prescribing error rate = 12.4% of prescriptions (491 of 3948) or 6.2% items (546 of 8686); 2.4% errors were serious</td>
</tr>
<tr>
<td>Shah et al.[55]</td>
<td>2001</td>
<td>UK</td>
<td>3 community pharmacies and 3 general practices located near the pharmacies</td>
<td>Retrospective analysis prescriptions from 23 doctors (three general practices) presented to three community pharmacies over the course of 2 months</td>
<td>Retrospective study</td>
<td>Prescribing</td>
<td>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)</td>
<td>Prescribing error rate of 7.46 per 100 items (95% CI 7.2–7.8); Errors were found on 140 of the 1373 handwritten items presented during the study period (10.2%) compared with 1233 of the 33 772 computer-generated items (7.9%) (chi-square 15.65, df = 1, P &lt; 0.0001)</td>
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<tr>
<td>Study</td>
<td>Year</td>
<td>Country</td>
<td>Participants</td>
<td>Methodology</td>
<td>Error Type</td>
<td>Description</td>
<td>Error Rate</td>
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<tr>
<td>O'Grady and Dean Franklin</td>
<td>2011</td>
<td>UK</td>
<td>11 community pharmacies</td>
<td>Prospective study</td>
<td>Dispensing, transcribing</td>
<td>Direct observation of dispensed items awaiting receipt by or delivery to patient</td>
<td>Content error rate = 1.7%; Labelling error rate = 1.6% (dispensed items)</td>
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<tr>
<td>Szczepura et al.</td>
<td>2009/2010</td>
<td>UK</td>
<td>A cohort of 345 older residents in 13 care homes (9 residential, 4 nursing)</td>
<td>Prospective study</td>
<td>Administration</td>
<td>Disguised observation technique using pharmacy-managed barcode medication administration system, BCMA</td>
<td>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</td>
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<tr>
<td>Warholak et al. (2009)</td>
<td>2006</td>
<td>USA</td>
<td>Outpatient computer-generated prescriptions (e-prescriptions) in five states</td>
<td>Prospective study</td>
<td>Prescribing</td>
<td>Participating pharmacists documented active interventions on e-prescriptions</td>
<td>Error rate = 3.8% prescriptions (102 interventions of 2690 e-prescriptions)</td>
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</tbody>
</table>
Incidence of medication errors in primary care

Of the studies reviewed, 12 were conducted in the USA, 10 in the UK, two in Bahrain, one each in Malaysia, Italy, Germany, Saudi Arabia, Denmark, Spain, India, Australia and Ireland between 1995 and 2013 and published between 1999 and 2012. Prescribing error rates were comparable across countries in some instances – Bahrain: 7.7% prescriptions[34]; UK: 7.5% and 5% prescriptions[19,55]; USA 7.6% and 11% prescriptions[12,52]; India 6.1% items [51] and Ireland 6.2% prescriptions.[54]

Of the studies reviewed, nine were conducted in primary care centres (general practices). Ten of the studies were conducted in the community pharmacy setting, ranging from one to 1146 pharmacies.[26,28,29,33,35,42,43,47,56,58] Two studies were conducted in care facilities – aged care[40] and nursing or residential homes.[20] Two studies each estimated medication error rates in elderly patients[24,40] and paediatrics.[15,48] One study was conducted in the primary care setting of a university.[43]

The parts of the medication management system studied were sometimes apparent from the article title, aims or objectives; other times, they were inferred from the methods reported or the results presented. The part of the medication system studied comprised the prescribing stage (26 studies),[12,19,20,22–29,33,34,41,43,46–55,58] transcription (four studies),[26,29,46,56] dispensing (10 studies),[20,26–28,35,40,42,43,47,56] monitoring (eight studies)[19,20,23,24,26,27,48,50] and administration (10 studies).[20,23–25,27,28,44,47,48,57]

The studies used differing methods to collect error data. These methods were either retrospective or prospective and varied with the part of the medicines management system being studied:

Studies, which evaluated prescribing or monitoring errors, used one of these methods: patient clinical record reviews,[12,19,20,22–24,41,43,48–50] prescription audits,[12,22,28,29,33,44,47,48,49,51,52,54,55,58] incident reports reviews,[26,27,42] patient surveys or interviews[12,21,48] and claims reviews.[46]

There were important variations even within methods; for instance, retrospective prescription reviews were conducted by reviewing patient medical records,[19] through pharmacists’ screening and intervention,[20] or researchers’ screening and/or observations.[22,33]

Dispensing errors were evaluated using one of these methods: direct observations of dispensing activities,[18] retrospective examination of dispensed medicines,[20,40,45,56] incident reporting[27] and review of self-reported incidents and ‘near misses’. [26,28,42,47]

It was sometimes difficult to interpret the methods used to detect and evaluate administration errors; of those clearly stated, the methods used were direct observation,[20] retrospective review of administration data[27] or patient records,[24,44] barcode systems,[57] patient surveys and/or self-reports,[23,47,48]

Three studies used more than one method to evaluate medication errors: in one study, prescriptions and clinical records were reviewed to evaluate prescribing errors.[19] in another, patient surveys and medical record review were both used to study monitoring errors;[20] and finally one study used medical record reviews and healthcare professional interviews to detect and evaluate prescribing and monitoring errors.[19]

Of the studies reviewed, only a few studies stated the error definition used (Table 2a). Two studies, which used the same definitions of prescribing and monitoring errors, had common authors.[19,20]

Varying denominators were used to calculate and determine error rates. As such, the units of expression varied between studies. Studies reviewed expressed error rates as: a percentage of total prescriptions,[12,19,22,26,29,33,44,48,52,54] patients,[19,23,26,40,43,48,50] items/packs,[15,42,46,49,51,54–57] opportunities for errors,[59] total errors[27,28] and in patient/person years.[24,44]

The highest error rates were recorded for the prescribing stage as follows: for paediatric patients: 90.5% of prescriptions (Bahrain)[33] and 74% of prescriptions (USA).[48] for elderly patients: 8.3% of opportunities for error,[20] and when all errors (including administrative errors such as illegibility with hand-written prescriptions) were recorded.[33]
Table 3  Interventions to reduce medication errors in primary care

<table>
<thead>
<tr>
<th>Interventions</th>
<th>References</th>
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<tbody>
<tr>
<td>1. Computerisation/electronic interventions:</td>
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<tr>
<td>• Computerised physician/provider order entry (with or without clinical decision support, CDS, e.g. monitoring alerts)</td>
<td>Gandhi et al. [32,13]; Devine et al. [17]; Palen et al. [30]; Tamblyn et al. [61,9]; Gandhi et al. [12]</td>
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<tr>
<td>• Electronic Health Record (EHR), electronic prescribing and electronic transfer of prescriptions</td>
<td>Abramson et al. [62]; Devine et al. [17]; Boockvar et al. [33]; Moniz et al. [64]; Nemeth et al. [83]</td>
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<tr>
<td>• Personal digital assistance with clinical decision support</td>
<td>Berner et al. [66]; Dallenbach et al. [67]</td>
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<tr>
<td>• EHR with weight-based prescribing (CDS)</td>
<td>Ginzburg et al. [68]</td>
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<tr>
<td>• CPOE with retrospective medication profiling</td>
<td>Glassman et al. [69]</td>
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<tr>
<td>• Community pharmacy Patient Medication Record (PMR) with drug interaction software/other alerts</td>
<td>Hazlet et al. [70]; Humphries et al. [71]; Raebel et al. [72]</td>
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<tr>
<td>• Authentication at the point of dispensing (stand-alone, PMR-linked and electronic transfer of prescriptions (ETP-linked)</td>
<td>Franklin and O’Grady [69]</td>
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<tr>
<td>• Pharmacy computer system with dispensing support (medication alert/verification)</td>
<td>Norden-Hagg et al. [73]; Raebel et al. [72]</td>
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<td>• Computer-assisted feedback between healthcare professionals</td>
<td>Avery et al. [74]</td>
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<td>• Pharmacy system improvement strategies</td>
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<td>2. Educational support, prescribing support and management:</td>
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<tr>
<td>• Academic detailing and educational outreach, Pharmacological profiling of patients, use of formulary/drug lists</td>
<td>Ahmad et al. [75]; Avery et al. [178]; Bregnhøj et al. [79]; Lafata et al. [177]; Lopez-Picasso et al. [78]; Nemeth et al. [80]; and Stefanovic et al. [90]</td>
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<td>3. Pharmacy or Pharmacist-led interventions</td>
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<tr>
<td>• Collaborations between pharmacists and prescribers (general practice)</td>
<td>Avery et al. [75]; Braund et al. [81]; Buurma et al. [82]; Humphries et al. [77]; Raebel et al. [72]; Bregnhøj et al. [79]</td>
</tr>
<tr>
<td>• Collaborations amongst healthcare providers (e.g. from other healthcare setting)</td>
<td>Booij et al. [82]; Sorensen et al. [83]</td>
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<tr>
<td>• Clinical Pharmacy Services</td>
<td>Wild et al. [84]</td>
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<tr>
<td>• Pharmacy-led bar code medication administration systems</td>
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<td>4. Medication reconciliation: medication reviews and medication monitoring</td>
<td>Bernstein et al. [85]; Varkey et al. [86]</td>
</tr>
<tr>
<td>5. Quality management strategies</td>
<td>Singh et al. [97]</td>
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</table>

*Studies demonstrating marginal impact (see footnotes 3 and 4 below) were included to reinforce the need for optimisation of interventions; †There was a significant reduction in therapeutic duplication problems in the computer-triggered group (odds ratio 0.55; P = 0.02) and no effect on prevalence of prescribing problems at follow-up; ‡Marginal improvements in ADE preventability was reported (16% in the Usual Care group and 17% in the Provider Feedback group had an associated warning; 95% CI for the difference, −7 to 5%; P = 0.79).*

The lowest error rates were recorded as follows: for incident report reviews: 23/10 000 prescriptions (prescribing error; Denmark) [88]; for dispensing error rates: 1.4/10 000 prescriptions (Denmark) [88]; 0.08% and 3.3% items and 3.99/10 000 items (UK) [59,61,66]; and in studies that focused on a specific prescribing category: 0.2% total items (Italy, interactions) [61]; 0.7% patients (USA, interactions) [60].

Previous systematic reviews and meta-analysis of interventions to prevent medication errors in primary care in the existing literature have demonstrated a weakness in the evidence of effectiveness interventions. [93–96] Most interventions have been individually implemented and evaluated.

**Discussion**

This review of the literature demonstrated that safety and quality issues currently exist at each stage of the medication management system, the prescribing stage being the most susceptible point. There is some evidence that children and the elderly are the more susceptible patient groups. Error rates ranged between <1% and 90% depending on the error definition, methods used and on the patient population being studied. Direct comparison across settings was difficult due to variation in methodology, definitions and units of measurements. However, when error rates were expressed with a common denominator, rates were comparable between countries. Collaborations between practice and research may...
provide cost-effective options to interventions to prevent errors and improve patient outcomes.\[6\]

This review has tried to present a holistic view of the safety of the medication use pathway in primary care across different healthcare settings and has evaluated a broad range of error types. By doing so, the susceptible points in the medicines use process and the most vulnerable patient populations were identified. The results are applicable across a range of healthcare settings and provide opportunities for stakeholders to influence practice and policies in a strategic, scientific manner.

One of the limitations of this review is the exclusion of the term ‘adverse drug event’ from the medication error terms, which may have meant that relevant articles were not identified. Furthermore, previous research show that patient safety incidents in hospitals take their roots from primary care management – in the UK, 6.5% admissions to hospital were related to adverse drug reactions in a study of 18,820 patients that were admitted to hospital.\[11\] Therefore, valuable insight may have been obtained from studying the admission–discharge interface. However, due to the varying nature of the primary–secondary care interface across countries, studies at the admission–discharge interface were not included. Lastly, studies included in this review were not of the same level of evidence; the aim was to provide an estimate of the incidence of medication errors in primary care. As such, limiting the studies to the same evidence levels would have precluded the international insight, which has been hopefully provided.

Most of the studies reviewed were actually conducted in community pharmacies, not within general practices\[26,28,29,33,42,45,47,56,58\] following patients’ receipt of their prescriptions from general practices – even though the

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**Figure 1** Flow chart of tiles screening.
studies are often described as ‘primary health centres’,[13,14,31,32,34,35] they may be better described as community based.

The number of sites and the duration of observation were highly variable; one study was actually done in one community pharmacy.[29] The absolute number of patients and/or prescription items is of significance based on the opportunities for errors. Only two studies[19,56] reported a systematic and scientific determination of sample size. The sampling period is also an important variable. Study periods need to consider the effect of seasonal variations on prescription volumes and types, and hence error rates. As such, prescription reviews conducted over a 1-week period as reported in some of the studies reviewed[33,34,47] are not necessarily representative of day-to-day practice.

Although some of the studies suggest that older and younger patients are more likely to experience a clinically significant medication error than the rest of the population,[19,20,38,97] only two studies each focused on elderly patients[34,40] and children.[33,48] With an aging population, comorbidities, polypharmacy,[43] contact with multiple providers,[43,90] and care transitions[30] are on the increase. The need for weight-based therapeutic interventions in children[90,99] and lack of readily available proprietary medicines in strengths suitable for paediatric dosing often necessitating titration have long influenced medication safety in the paediatric setting. Moreover, the elderly and children use primary healthcare more than the rest of the population with implications for medication safety in the face of the ever-pressured healthcare system. There is therefore an urgent need for more research into medication safety among these patient populations.

Previous researchers have identified the prescribing and administration stages as the most dangerous stages of the medicines management system.[13] Twenty-six of the 33 studies reviewed evaluated the prescribing stage in keeping with this finding. There is some suggestion in the existing literature that errors occur when patients take their medicines and that there is a need to prioritize processes at the patient end of the system for interventions.[85] This review showed that there is a shortage of studies at the ‘patient end of the system’ because of the obvious difficulties. Nonetheless, there is substantial evidence in practice that many patients may not be using their medicines as directed, resulting in therapeutic failure and hospital admissions.[109–111] Research and practice must therefore overcome the challenges of evaluating medication administration quality and safety in primary care to improve patient health outcomes.

Although the use of varying error definitions by researchers in determining error rates has been previously identified,[13,36,37,101] this review has confirmed that this problem still exists. This is reflected in the wide range (<1–90%) of error rates reported. Such variance in definitions and data capture could lead to erroneous evaluations of the system causes of error. Attempts to develop common definitions for practice and research have been made,[36,37,99] and although more studies and practice in secondary care are adopting the use of these definitions,[104] there is still significant variation among the studies reviewed. One study[19] adapted a definition developed in secondary care for use in primary care but due to differences in the medication handling system between both settings, this approach may be burdensome, difficult to interpret and result in loss of important data. There is a need for a primary care practitioner-led definition of a prescribing error, where the highest error rates are recorded.

This review has also demonstrated that error rates varied with the method of identification. For example, the highest error rate of 90.5% prescriptions[33] was recorded in Bahrain following the audit of paper prescriptions issued for paediatric patients from 20 primary healthcare centres. Although all errors, including illegibility were captured, this figure excluded ‘minor errors of omission’. When paper prescriptions were reviewed in a prospective cohort study in the USA, 94% of all medication errors (74% prescriptions) recorded were at the prescribing or ordering stage.[46] Although it may be argued that systems, which produce minor errors like incomplete prescriptions, are also able to produce major errors that lead to patient harm,[21] defences within the system would intercept some ‘minor’ errors such as illegibility; for example, a clinical check on a prescription prior to dispensing by a pharmacist is a major ‘defence process’. Conversely, in healthcare systems where pharmacists’ roles are circumvented (such as in a dispensing practice) or otherwise undeveloped (as in most developing countries), there is a breakdown in this defence.

A high prescribing error rate of 8.3% opportunities for error or 39% of all patients was also recorded in a study of elderly patients in residential and care homes.[20] The methods used to record medication errors were robust, comprising patient interviews, note reviews, practice observations and dispensed items examination. This was possible because all elements of the methods were applicable on the same sites. Incomparably with other studies, the dispensing error rate in this study was higher than both the prescribing and administration error rates reported in the same study. In the healthcare setting in this study, general practitioners and community pharmacists manage home patients’ prescribing and dispensing activities. These patients also have carers who provide their intermediate healthcare needs, including medication administration. The challenge with this arrangement is that vulnerable patients who need health care the most do not have ample opportunities to interact directly with their practitioners and pharmacists. The use of cassette type monitored dosage systems appear to be a practical solution for dispensing their medication, but the study demonstrated that the incidence of dispensing errors is highest with this type of
delivery system. Should nursing and residential homes be viewed and treated like subsets of secondary care? This is a policy issue that should be thoroughly evaluated.

The lowest error rates were from data captured from incident reports – prescribing error study in Denmark (23/10 000 prescriptions/0.23% prescriptions)\(^\text{88}\) and in a US study.\(^\text{27}\) This is in keeping with the literature. Although incident reporting is very useful for organizational error learning and provides valuable feedback to practitioners,\(^\text{105}\) research has shown that they can grossly underestimate error rates.\(^\text{105,106}\) In the study in Denmark, community pharmacists documented prescription errors, which they had intercepted. Although community pharmacists are a practical source of data and perform important error interceptions,\(^\text{107,108}\) under-reporting remains a risk when pharmacy owners or managers collect study data themselves as evident in the lower rates reported in such studies.\(^\text{28–29,35,42,47,58}\) In addition, when error rates are determined solely by recording pharmacists’ prescription interventions, the lack of access to patients’ medical histories at the time of data collection may become a barrier to adequate evaluation of the safety and quality of prescribing.

Review of patient medical or clinical notes in general practices is perceived as a rigorous method for collecting prescribing error data.\(^\text{106}\) This is reflected in this review as the studies, which included an example of case note reviews reported consistently higher rates of errors even across countries when compared with the use of incident reports and review of pharmacists’ interventions (Table 2). However, notable issues around patient confidentiality, informed consent and ethical provisions preclude access to patient medical records and prolong study duration. The gold standard is the use of a mix of methods for data collection,\(^\text{106}\) as a study showed no overlap when five methods were used.\(^\text{109}\) Studies, which used a mix of methods to evaluate the safety and quality of the medication system provided pertinent information such as causes of prescribing errors, clinical significance of errors, patient harm and resultant hospital admission.\(^\text{19,20,44,48}\)

Dispensing error rates were consistently low across countries. A UK study where researchers directly observed dispensed items found higher rates than those studies where incident reporting and review of ‘near misses’ were used, emphasising the issue of under-reporting. The additional checks incorporated in the dispensing process impact accuracy. On another hand, the potential for detecting dispensing errors by patients is low when compared with the detection of prescribing errors by pharmacists and other healthcare professionals.

It can be difficult to compare error rates when they are expressed in varying units: as percentage of prescriptions or items,\(^\text{12,19,22,33,34}\) packs/doses prescribed, dispensed or administered;\(^\text{40,42}\) multiples of items or packs;\(^\text{35,46}\) opportunities for errors;\(^\text{20}\) total number of patients recruited to the study\(^\text{43}\) and in patient or person years.\(^\text{24,41}\) The use of varying denominators can also lead to variation in reported percentages. Based on the large volumes of prescription items used in primary care, error rates expressed as a percentage of total prescriptions or items will make easier interpretation.

It is interesting to note that when comparable denominators were used, there is much consistency in prescribing error rates across countries: Bahrain: 7.7%\(^\text{134}\); UK 7.5% and 5%\(^\text{10,55}\); USA 7.6% and 11%\(^\text{12,52}\); India 6.1% items\(^\text{134}\) and Ireland 6.2% items.\(^\text{54}\)

### Optimising interventions to prevent medication errors in primary care

Error-prevention strategies help to improve patient health outcomes and reduce healthcare costs associated with drug-related harm.\(^\text{110}\) During the last decade, strategies to prevent error occurrence have been directed at secondary care.\(^\text{31}\) Attention is now being paid to methods for improving medication safety in primary care (Table 3). Interventions have been mostly implemented to individual parts of the medicines management system, without important collaborations between research and practice. Implementing interventions in an isolated manner may provide minimal effects as observed in previous studies.\(^\text{61,69}\)

Health care is a complex system with an overarching aim of improving patient health outcomes. Isolated, spontaneous reactions to serious critical incidents without rigorous evaluations of the interactions between various units of the system only yield multiplicity of similar interventions with slight and ineffective modifications. Indeed, a systematic review and meta-analysis of interventions in primary care demonstrated the weakness of the evidence for effectiveness of interventions aimed at reducing hospital admissions or preventable drug-related morbidity.\(^\text{20}\)

With an aging population, availability of innovative but more expensive therapeutic agents, and tight healthcare budgets, optimising existing interventions becomes necessary. In the recently published Pharmacist-led Information Technology Complex Intervention (PINCER) Study, simple feedback plus PINCER (an educational outreach and dedicated support) in general practice, patients in the intervention group were significantly less likely to have experienced a range of medication errors.\(^\text{14}\) This intervention demonstrated the benefit of collaborative interventions to improve the safety of medication use in primary care and ultimately improve patient health outcomes.

### Conclusion

This review has provided an international perspective on the safety of medication use in primary care across the medication management system. Targeting the more susceptible
population groups and the most dangerous aspects of the system may be more effective to error prevention in primary care. Collaborative implementation of existing interventions may offer time- and cost-effective options to improving medication safety and patients’ health outcome in primary care.

**Declarations**

**Conflict of interest**

The authors declare no conflict of interest.

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