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Pharmacist-led primary care interventions to promote medicines optimisation and reduce overprescribing: a systematic review of UK studies and initiatives

Journal:	BMJ Open
Manuscript ID	bmjopen-2023-081934
Article Type:	Original research
Date Submitted by the Author:	09-Nov-2023
Complete List of Authors:	Chambers, Duncan; The University of Sheffield, ScHARR; Preston, Louise; University of Sheffield, ScHARR Clowes, Mark; University of Sheffield, ScHARR Cantrell, Anna; University of Sheffield, ScHARR Goyder, Elizabeth; ScHARR, University of Sheffield
Keywords:	Primary Care < Primary Health Care, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Patient-Centered Care, Systematic Review

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Pharmacist-led primary care interventions to promote medicines optimisation and reduce overprescribing: a systematic review of UK studies and initiatives

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Conflict of interest: The authors have no conflicts of interest to declare

Total word count: Main text including tables 8040

Keywords: Overprescribing, deprescribing, medicines optimisation, primary care, pharmacist, United Kingdom, scoping, systematic

Funding and registration: NIHR Health Services & Delivery Research
Programme (project number NIHR135767). PROSPERO registration number
CRD42023396366. The full protocol is available online at
https://fundingawards.nihr.ac.uk/award/NIHR135767

Abstract

Objectives: To systematically review and synthesise evidence on the effectiveness and implementation of pharmacist-led interventions to promote medicines optimisation and reduce overprescribing in UK primary care.

Design: Systematic review

Setting: UK primary care

Methods: We searched MEDLINE, Embase, CINAHL and The Cochrane Library for UK-based studies published between January 2013 and February 2023. Targeted searches for grey literature were conducted in May 2023. Quantitative and qualitative studies (including conference abstracts and grey literature) that addressed a relevant intervention and reported a primary outcome related to changes in prescribing were eligible for inclusion. Quality of included studies was assessed using the Multiple Methods Appraisal Tool (MMAT). We performed a narrative synthesis, grouping studies by publication status, setting and type of data reported (effectiveness or implementation).

Results: We included 14 peer reviewed journal articles and 11 conference abstracts, together with four case study reports. The journal articles reported 10 different interventions, five delivered in general practice, four in care homes and one in community pharmacy. The quality of evidence was higher in general practice than in care home settings. It was consistently reported that the intervention improved outcomes related to prescribing, although the limited number of studies and wide range of outcomes reported made it difficult to estimate the size of any effect.

Implementation was strongly influenced by relationships between pharmacists and other health and care professionals, especially GPs. Implementation in care homes appeared to be more complex than in general practice because of differences in systems and 'culture' between health and social care

Conclusions: Pharmacist-led interventions have been shown to reduce overprescribing in primary care settings in the UK. More research is needed in community pharmacy settings; to assess intervention effects on patient outcomes other than prescribing; and to investigate how reducing overprescribing can impact on health inequalities.

Registration: PROSPERO [CRD42023396366].

Strengths and limitations of this study

We included evidence often excluded from systematic reviews to get as full a picture as
possible of how pharmacist-led interventions are implemented and sustained in practice as
well as their characteristics and effectiveness.

• Some review processes were performed by a single reviewer and meta-analysis was not feasible.



Introduction

Overprescribing has been defined as 'the use of a medicine where there is a better non-medicine alternative, or the use is inappropriate for that patients' circumstances and wishes'[1]. Overprescribing is often related to the concept of problematic polypharmacy, where harmful effects result from the prescription of multiple medications. However, there is no agreed definition of polypharmacy and patients with complex health conditions may require multiple medications.

Medicines optimisation is an umbrella term for interventions designed to ensure that medicines are used safely and effectively, producing the best possible outcomes for patients. In this context, deprescribing refers to the process of stopping medications that are no longer appropriate to a patient's needs. Deprescribing is a response to overprescribing and problematic polypharmacy and involves collaboration between health professionals and patients and/or carers to ensure shared decision-making. Another related term, medicines reconciliation, is a more technical process to ensure consistency between prescription records and the medications the patient is actually receiving and taking. The terminology around overprescribing and other forms of medicines misuse was recently reviewed by Singier et al[2]. Medication review involves examining a patient's prescriptions as a whole and is separate from measures to reduce inappropriate prescribing of specific medications or types of medication such as antibiotics or proton pump inhibitors.

Overprescribing can cause direct harm to patients in a variety of ways. It has been estimated that about 6.5% of hospital admissions are caused by harmful effects of medication, rising to 20% for people aged over 65[1]. In addition to physiological harms, long-term use of some medications can lead to dependency and problems when attempting to withdraw the medication.

Issues relating to prescribed medication can arise from a whole range of causes, including patients requiring treatment for multiple conditions, lack of co-ordination between different health professionals or organisations and failures of communication between health professionals and patients (for example failing to gather information because of time constraints on appointments). Availability of new medications and increasing numbers of people living with long-term conditions such as arthritis and diabetes have resulted in patients being prescribed more medications and continuing to take them for long periods of time, often for life. The average number of prescription items per head of population doubled between 1996 and 2016, and over 75% of prescriptions are repeat prescriptions[1].

In addition to their fundamental role in preparing and dispensing medicines, pharmacists are trained to provide advice and support to patients and other health professionals. While most prescriptions are ordered by doctors, pharmacist independent prescribers (PIPs) have existed since 2006 and patients are increasingly asked to consider the community pharmacy as a first source of support for minor health conditions. Alongside community pharmacies, many general practices have pharmacists as members of the practice team.

Pharmacists are thus well placed to support processes of medicines optimisation, which involve them working closely with medical professionals (particularly GPs), commissioners of health care and patients. The report of the National Overprescribing Review for England, published in 2021, provides numerous examples and case studies[1]. Shared decision-making with patients and/or carers is fundamental to successful medicines optimisation[3] but the need for time and resources to ensure that this takes place can create barriers to service delivery.

The National Overprescribing Review (NOR) for England was set up in 2018 to evaluate the extent of overprescribing in the NHS and recommend measures to reduce it, particularly in primary care. A review of existing research (overview of systematic reviews) was commissioned to support the national review[4]. The NOR identified a need for a more consistent and effective approach to medication review, which requires both the identification of effective interventions and an understanding of the factors that need to be addressed in terms of organisational and cultural barriers to implementation. The national review's recommendations included changes to systems (patient records, transfers of care and clinical guidance) and culture (reduced dependence on medication and support for shared decision-making), as well as the appointment of a National Clinical Director for Prescribing[1].

This evidence review was commissioned to support implementation of the NOR recommendations by examining research on pharmacist overprescribing interventions in UK primary care settings. We aimed to assess the effects of relevant interventions on outcomes related to prescribing, identify key characteristics of the interventions and examine barriers and facilitators to implementation in routine practice. A further aim was to assess the quality of the evidence base and identify priorities for further research. In addition to this UK-focused paper, outputs from the project include a broader scoping review of reviews of interventions for overprescribing in primary care (Preston et al. in preparation) and an evidence-based analysis of factors for service commissioners and providers to consider in developing and delivering services to reduce overprescribing and optimise medication use.

Methods

i.

Review aims and objectives

We aimed to perform a systematic review of published literature and published or informally published evaluations reporting UK-based, pharmacist-led interventions for overprescribing, including the following components:

- A review and synthesis of outcomes of effective interventions
- ii. A review of the characteristics of effective interventions using the TIDieR framework
- iii. Evaluation of the UK evidence base in terms of quality and risk of bias
- iv. Identification of case study examples of effectively implemented interventions in the UK

Inclusion and exclusion criteria

Inclusion criteria for the review were as follows

- Population/setting: UK primary care
- Intervention: Pharmacist-led interventions aimed at review and optimisation of prescribed medications
- Comparator: Not required
- Outcomes: Studies had to report a primary outcome related to changes in prescribing.
 Secondary outcomes were other patient and health service outcomes, including but not limited to changes to type of medicines prescribed, quality of life, hospital admissions and deaths.
- Study design: Quantitative and qualitative studies were eligible for inclusion, with no
 exclusions based on study design or quality. Reports of local initiatives published as grey
 literature reports or conference abstracts were included to give a fuller picture of activity
 across the NHS.
- Other: Studies published in English between January 2013 and February 2023

We excluded interventions aimed at reducing overprescribing of specific medications or types of medication, e.g. antibiotics or proton pump inhibitors. Studies of children and young people were also excluded.

Search methods

A common literature search was performed for this review and the associated scoping review of reviews (Preston et al. in preparation). Searches were conducted by an information specialist (MC) in order to identify published and unpublished evidence on primary care interventions to reduce overprescribing.

A first phase of database searches was run in February 2023 to retrieve relevant peer-reviewed literature. Searches were designed around the following concepts:

PROBLEM	INTERVENTION	SETTING
Overprescribing; Inappropriate prescribing; polypharmacy	Deprescribing; Structured medication review; medication reconciliation; medicines optimisation; shared decision making; personalised care	Primary Care (including international terms for primary care where relevant)

While we are aware of the Morel filter (2022) for identifying studies of deprescribing[5], our focus was specifically on a primary care setting. Search strategies are provided in Appendix 1 (see supplementary files).

Searches covered the databases MEDLINE, Embase, CINAHL and The Cochrane Library and were limited to studies published since 2013 and in OECD countries with healthcare systems similar to the UK.

Phase 2: grey literature

A further phase of targeted searches was conducted in May 2023 to identify unpublished or "grey" literature. This involved searching for the case studies identified by the National Overprescribing Review (to identify any which had produced a report or evaluation), and then searching the Overton.io platform for pharmacist-led deprescribing/overprescribing and medicines optimisation.

Searches were complemented by input from stakeholders (internal and external topic advisers) to minimise the risk of missing any other relevant evidence.

Study selection

Records retrieved by the literature search were stored in a shared EndNote library and deduplicated. Screening for inclusion at the title level was performed by single reviewers after piloting of a test set. Reviewers could refer records to another team member in the event of uncertainty and a 20% sample of records was screened by a second reviewer to validate title level inclusion decisions.

Screening for inclusion at the abstract and full text level was performed by pairs of reviewers acting independently. Disagreements were resolved by discussion among the reviewers involved (AC, DC and LP). Reasons for exclusion at the full text stage were recorded.

Data extraction

Data extraction tables and summary tables were developed in Microsoft Word. Extraction was performed by a single reviewer, with a 10% sample being checked for consistency and accuracy. In addition to standard data extraction fields (study design/sample size, setting, intervention, key findings and strengths/limitations), we used the TIDieR Lite framework to collect information on the features of interventions reported as 'successful' to determine whether service commissioners and providers should consider specific factors when commissioning/delivering services. TIDieR Lite is a simplified version of the TIDieR (Template for Intervention Description and Replication) checklist [6].

Quality assessment

Methodological quality of peer reviewed journal articles was assessed using the Mixed Methods Appraisal Tool (MMAT) version 2018[7]. The tool includes screening questions and methodological quality questions for different study designs (qualitative, randomised trials, non-randomised quantitative studies, descriptive studies and mixed methods). Quality assessment results were combined with identified strengths and limitations (including those reported by study authors) to characterise the contribution of individual studies and groups of studies to the overall evidence base.

Data synthesis

We performed a narrative synthesis of the included studies using text and tables to describe study and intervention characteristics in line with methodological and reporting guidelines[8, 9]. We initially grouped studies by publication status, considering peer-reviewed journal articles (regardless of study design and quality) separately from conference abstracts and case studies. Within these three categories, we grouped studies by setting (general practice, care homes or community settings). We also distinguished between studies reporting effectiveness of interventions and those reporting implementation of interventions (e.g. qualitative studies and process evaluations). In view of study heterogeneity and reporting limitations, effectively implemented interventions were defined as those where the study authors' conclusions indicated that the service was regarded as a success and was planned to continue or be expanded.

Studies reported a wide variety of outcomes using diverse effect measures. For this reason we did not attempt to calculate a standardised metric to compare effect sizes across outcomes. The synthesis used a 'vote-counting' method (number and proportion of studies reporting positive, negative or neutral outcomes), prioritising prescribing-related outcomes over patient and other outcomes. Reported effect measures and associated 95% Cls were recorded in the text and tables. Tables of study characteristics and findings were presented alphabetically by author for consistency. While reporting results from all study designs we prioritised stronger study designs (experimental and quasi-experimental) over those of uncontrolled observational studies. In terms of exploring heterogeneity, the structure of the synthesis allowed consideration of potential modifiers including study design, study quality and setting. Intervention components and aspects of implementation were examined using modifications of existing frameworks, the component analysis was prespecified in the review protocol.

Public involvement

The review was supported by a public panel who provided feedback on public perceptions that informed the review and are reflected in the Discussion.

Variations from protocol

We used Tidier Lite instead of the full TIDieR framework. This was because the full framework is designed to allow the replication of interventions and therefore goes beyond the degree of detail required for evidence synthesis.

Results

Results of literature search

The PRISMA flow diagram (Figure 1) summarises the study selection process. After screening 1774 records at the title and abstract stage and 215 full-text articles, we included 14 published articles, 11 conference abstracts and four case study reports. The majority of exclusions were of studies conducted outside the UK, with a smaller number excluded because the intervention was not pharmacist—led or the article did not report empirical data. Characteristics of the included studies are reported in the following sections.

Research studies

Study characteristics

Study characteristics are summarised in Table 1, with full data extraction tables in Appendix 3 (see supplementary files). The 14 publications reported on ten interventions, of which five were delivered in general practice (seven publications[11-17]), three in care homes for older people (five publications[18-22]), one in care homes for people with intellectual disabilities (ID) [23] and one in community pharmacies[24].

All the interventions involved medication review in some form. Distinctive features of interventions included use of IT to identify patients for review[11-13, 15, 16]; a key role for pharmacist independent prescribers in medication management in care homes[21, 22]; and employment of pharmacists by groups of general practices (primary care networks, PCNs) to provide a holistic patient-centred service specified by NHS England[14]. Intervention characteristics are considered in more detail below.

Study designs used included one individual RCT[17] and two cluster RCTs (CHIPPS[18, 21] and PINCER[11]), although the primary publications of the latter two trials fell outside the time period covered by this review. Two studies used an interrupted time series (ITS) design[15, 16] and five used qualitative approaches[12-14, 18, 22]. One study was a mixed methods process evaluation[21]. The remaining studies were described as service evaluations or quality improvement reports with an uncontrolled before vs. after design [19, 20, 23, 24].

Included studies reported a wide range of outcomes (Table 1). For further analysis, see below under 'effects of interventions' and 'Implementation/system issues, respectively. None of the studies reported details of participants other than age and sex, making it difficult to assess equity, diversity and inclusion across the evidence base.



Table 1: Summary of research study characteristics

able 1: Sum	mary of research study charac	eteristics		bmjopen-2023-081934 on 7
Reference	Population	Intervention	Study design	Ogtcome measures
Alharthi 2023[18]	Care home residents	Deprescribing by pharmacist independent prescriber	Qualitative interviews with participants in a cluster RCT (CHIPPS study)	Barders and facilitators to deprescribing religions and facilitators to deprescribing religions to the second seco
Alves 2019[19]	Care home residents	Medication review by primary care pharmacists linked to GP practices	Service evaluation (5 year uncontrolled study)	In है के किया किया किया किया किया किया किया किया
Baqir 2017[20]	Care home residents	Medication review by pharmacist with or without GP	Retrospective analysis of data from QI programme	Ngrmer and type of medications stopped
Birt 2021;[21]	Care home residents	Pharmacist independent prescribers responsible for medicines management (CHIPPS)	Mixed methods process evaluation	PA activities, perceived benefits and barries to implementation
Howard 2014[11]	Pharmacists delivering intervention	IT-enabled pharmacist-led review to reduce medication errors	Cluster RCT (PINCER trial)	Time taken to complete reviews; reconsmended interventions and whethe they were implemented
Jeffries 2018[12]	Pharmacists delivering intervention, GPs and CCG staff	Pharmacist-led intervention involving the use of an electronic audit and feedback surveillance dashboard to identify patients potentially at risk of hazardous prescribing or monitoring of medicines in general practice	Qualitative interviews	The mes related to implementation of the ingervention and role of practice pharmacists and others 20 20 20 20 20 20 20 21
Jeffries	Stakeholders in general	Electronic medicines optimisation	Qualitative realist	Suggestions to support implementation o
2017[13] Lane 2020[22]	practice and CCG Doctors, pharmacists, care-home managers and	Pharmacist independent prescriber service	evaluation Qualitative focus groups and interviews	the system Perceimed benefits of the service and barries and facilitators to implementation

Peak General practice patients with one or more risk factors for hazardous prescribing or inadequate blood test monitoring East Midlands Patients in participating GP practices at risk of MRPs Thayer Care home residents with 2021[23] Thayer Care home residents with 2021[23] Trailing Patients over 65 community pharmacists and a specialist mental health pharmacists roview of medication review using Structured medication review service within Primary Care Networks Supprescribed four or more Structured medication review service within Primary Care Networks Supprescribed four or more Structured medication review service within Primary Care Networks Supprescribed four or more Structured medication review service within Primary Care Networks Supprescribed four or more Structured medication review service within Primary Care Networks Supprescribed four or more Structured medication review service within Primary Care Networks Supprescribed four or more Structured medication review service within Primary Care Networks Supprescribed four or more Structured medication review service within Primary Care Networks Supprescribed four or more Structured medication review service Supprescribed four or more Study Supprescribed four or more with intervention Study Supprescribed four or more with intervent		BMJ Open		bmjopen-2023-081934 c
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Rodgers General practices in the East Midlands Pharmacist-led IT intervention (PINCER) Multiple interrupted time series participating on medication optimisation Pharmacists and a specialist mental health pharmacist providing review of medicines and lifestyle risk factors Pharmacist-led IT intervention (PINCER) Multiple interrupted time series pass clinical outcomes and pass clinical outcomes and costs MRPs Care home residents with intellectual disabilities Collaborative service initiative involving community pharmacists and a specialist mental health pharmacist providing review of medicines and lifestyle risk factors Twigg Patients over 65 prescribed four or more Pharmacist-supplemented care focusing on medication optimisation Pharmacist-supplemented care focusing Individual RCT Service evaluation Service evaluation Service evaluation Service evaluation Number of recommendations; falls, medication adherence, quality of life and	General practice patients with one or more risk factors for hazardous prescribing or inadequate	,	1	Rate (prevalence) of potentially hazardou present the properties of potentially hazardou present the properties of the p
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Twigg Patients over 65 Community pharmacist consultation Service evaluation prescribed four or more including medication review using Service evaluation Number of recommendations; falls, medication adherence, quality of life and		community pharmacists and a specialist mental health pharmacist providing review of medicines and lifestyle risk	Service evaluation	in erwentions/recommendations and acceptance by GPs and psychiatrists
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		relatives Pharmacists working in general practice within PCNs General practice patients with one or more risk factors for hazardous prescribing or inadequate blood test monitoring General practices in the East Midlands Patients in participating GP practices at risk of MRPs Care home residents with intellectual disabilities Patients over 65 prescribed four or more medications	staff, residents and relatives Pharmacists working in general practice within PCNs General practice patients with one or more risk factors for hazardous prescribing or inadequate blood test monitoring General practices in the East Midlands Patients in participating GP practices at risk of MRPs Care home residents with intellectual disabilities Patients over 65 prescribed four or more medications Structured medication review service within Primary Care Networks Pharmacist-led Safety Medication dASHboard (SMASH) intervention Pharmacist-led IT intervention (PINCER) Pharmacist-supplemented care focusing on medication optimisation Collaborative service initiative involving community pharmacists and a specialist mental health pharmacist providing review of medicines and lifestyle risk factors Community pharmacist consultation including medication review using STOPP/START rules	staff, residents and relatives Pharmacists working in general practice within Primary Care Networks General practice patients with one or more risk factors for hazardous prescribing or inadequate blood test monitoring General practices in the East Midlands Patients in participating GP practices at risk of MRPs Care home residents with intellectual disabilities Patients over 65 prescribed four or more Structured medication review service within Primary Care Networks Structured medication review service Qualitative interview study Structured medication review service within Primary Care Networks Structured medication review service within Primary Care Networks Structured medication review service of methods and including medication review using Structured medication review service Qualitative interview study Interrupted time series analysis Interrupted time series analysis Service valuation Service evaluation Service evaluation Service evaluation including medication review using

Table 2: Summary of studies reporting effects of interventions

Table 2: Sum	mary of studies reporti	ng effects of interven	BMJ Open	bmjopen-2023-081934 on
Reference	Intervention	Setting	Study design and sample size	Outcome measure and effect size
Alves 2019[19]	Medication review	Care homes	Service evaluation 10,405 patient reviews over 5 years	Interventions by pharmacisation to the control of t
Baqir 2017[20]	Medication review	Care homes	Retrospective evaluation of quality improvement project 422 residents in 20 care homes	Number and type of medical hos stopped 19.5% reduction in number of medicines being prescribed relative to baseline the stopped from http://www.cast.com/ning.
Peek 2020[15]	Safety medication dashboard	General practice	Interrupted time series 43 general practices covering 235,595 people in Salford, Greater Manchester	Potentially hazardous preschibing (composite of 10 indicators) Potentially hazardous preschibing reduced by 27.9% (95% CI 20.3% to 36.8%, $p < 0.001$) at 24 verified and by 40.7% (95% CI 29.1% to 54.2%, $p < 0.001$) at 12 months.
Rodgers 2022[16]	Pharmacist-led IT- assisted intervention (PINCER)	General practice	Multiple interrupted time series 393 general practices covering approximately 3 million patients	Indicators of potentially hazardous prescribing The PINCER intervention was associated with a decrease in the rate of hazardous prescribing of 6.2% (adjusted odds ratio (aOR) 0.83, 95% confidence interval (CS 0.86) at 6 months and 15.3% (aOR 0.85, 95% CI 0.80 to 0.86) at 12 months post-intervention
Syafhan 2021[17]	Pharmacist-led medicines optimisation	General practice	Individual RCT 356 patients at risk of medication-related	Medication-related problems (\P RP); Medicines Appropriateness Index (MAI) Median number of MRPs per intervention patient at 6 months was reduced from 3 to 0.5 ($p < 0.00$) in patients who received the full

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Thayer 2021[23]	Review of medicines and lifestyle risk factors	Care homes for adults with intellectual disabilities (ID)	problems (MRPs) from 8 GP practices Service evaluation 160 care home residents with ID	intervention schedule. MAlacoges were reduced (medications more appropriate) for the intervention group, but not for control group. Pharmacist interventions/recommendations and acceptance by GPs and psychiatrists
Twigg 2015[24]	Community pharmacist consultation including medication review	Community pharmacies	Service evaluation 620 patients (aged over 65 years and prescribed	Number of recommendations of life and costs at 6 months of superieur.
				bmjopen.bm
			≥ 4 medications	ning, Al training, and similar technologies.

Intervention characteristics

Appendix 3 Table 1 (see supplementary files) summarises characteristics of the included interventions using the TIDieR Lite checklist. The table includes limited data extracted from studies cited by included studies but not themselves included in the review [25-27].

The pharmacists involved in delivering the interventions were variously described as pharmacist independent prescribers[21]; trained pharmacists and pharmacy technicians[11, 16]; primary care pharmacists[19]; clinical pharmacists working in general practice[13-15]; GP practice-based pharmacists working as part of a wider primary care team[17]; community and specialist mental health pharmacists[23]; and community pharmacists and pharmacy team members[24]. One study simply referred to 'pharmacists'[13].

Four interventions were explicitly stated to require training of pharmacists to deliver them[11, 17, 21, 24]; the extent of training was described for three of these[17, 21, 24]. Training pharmacists to deliver the PINCER intervention was described in a separate paper[11]. Interventions were delivered with other primary care team members depending on the setting of the study and in some cases with staff employed by clinical commissioning groups (CCGs). In particular, only the CHIPPS study involved pharmacists with the power to prescribe medication independently; in other studies recommendations were passed to the patient's GP or another medically qualified professional for implementation. Shared decision-making with patients and/or families was specifically reported for three interventions[14, 17, 20].

Reporting of interventions varied between studies. Most studies reported the process of medication review including patient selection for review and the review itself in more detail than resulting follow-up actions. Two qualitative studies reported limited details of the review process[12, 14], although a service specification was available for the NHS England SMR investigated by Madden et al.[14]. For studies where the intervention was primarily directed at improving medication review processes using general practice data[11-13], it was unclear whether there was a standard process to discuss findings with the patient and make changes to their prescriptions. All studies reporting on effectiveness of medication reviews stated that the person undertaking the review had access to relevant patient records[15-17, 19, 20, 23, 24].

Intensity of interventions was also variably reported. In the CHIPPS study, PIPs committed a minimum of 16 hours/month to deliver care to approximately 20 care home residents[25]. Madden et al. reported that SMR appointments were recommended to allow at least 30 minutes for review and shared decision-making[14]. The medicines optimisation intervention evaluated by Syafhan et al. involved up to three meetings between patient and pharmacist[17], while the FOMM study in community pharmacies estimated times of 25 minutes for initial consultation, 10 minutes for monthly review and 11 minutes for quarterly review[24]. Other studies reported that time and level of support allocated to interventions varied between and within CCG areas depending on local resources and priorities[16, 19]. Another measure of intervention intensity was the number of recommended actions, averaging 3.3/resident in care home residents with IDs[23].

Most included studies reported on a single round of medication reviews with variable periods of follow-up. As noted above, some interventions required multiple interactions between pharmacists and patients.

Effects of interventions

 Seven studies reported on effects of pharmacist-led interventions in some form (Table 2): three in general practice[15-17], three in care homes[19, 20, 23] (including one in a care home for people with ID[23]) and one in community pharmacies[24].

The strongest evidence for the effectiveness of interventionscame from the studies in general practice. The interrupted time series (ITS) studies of Peek et al.[15] and Rodgers et al.[16], which used indicators of inappropriate prescribing to identify patients for intervention, reported significant decreases in inappropriate prescribing at 6 and 12 months after intervention (Table 2). Estimated reductions were larger in Peek et al. (27.9% and 40.7%) compared with Rodgers et al. (16.7% and 15.3%)[15, 16]. The 95% confidence intervals of the two studies at 12 months did not overlap, suggesting some uncertainty about the magnitude of the effect. The randomised trial by Syafhan et al.[17] preferentially recruited patients based on prescription of six or more medications and a history of recent unplanned hospital admission. The intervention was associated with a reduction in medication-related problems in those who completed the full programme (up to three appointments) and an improvement in MAI scores.

Of the three studies set in care homes, only Baqir et al. reported a direct effect on prescribing associated with medication review, a 19.5% reduction in number of prescribed medicines[20]. Alves et al.[28] reported on pharmacist interventions and potential financial savings over 5 years. In the one year reported in detail, 24.5% of interventions involved deprescribing. Potential drug cost savings were estimated at £812,441 annually, of which £431, 493 (55%) was attributed to deprescribing. The study of Thayer et al.[23] differed from the others in involving care home residents with ID. There was a high level of polypharmacy at baseline and pharmacists made an average of 3.3 interventions/recommendations per resident, of which 12.8% involved deprescribing. A large majority of pharmacist recommendations were accepted by GPs/psychiatrists caring for the residents.

The one study in a community pharmacy setting recruited patients aged 65 or older who were prescribed four or more medications[24]. Of 620 patients recruited, 441 (71.1%) completed the 6-month study. Pharmacists made 142 recommendations related to 110 patients, largely dealing with potentially inappropriate prescribing of NSAIDs and PPIs or duplication of therapy. The study also reported a significant decrease in falls and improvements in medication adherence and quality of life at follow-up.

The review included two publications from the CHIPPS Care Homes Independent Pharmacist Prescriber Study) trial[18, 21] but the paper reporting effectiveness and safety results from this cluster RCT[29] was published too late for formal consideration for inclusion in our review. The primary outcome was rate of falls, with Drug Burden Index (DBI) being one of the secondary outcomes. Fall rate at 6 months did not differ significantly between intervention and control groups

but DBI was lower in the intervention group (mean 0.66 vs. 0.73; adjusted rate ratio 0.83, 95% CI 0.74 to 0.92).

Implementation/system issues

Seven studies provided quantitative and/or qualitative evidence on factors affecting implementation of pharmacist-led interventions, of which four were performed in general practice[11-14] and three in care homes[18, 21, 22].

The general practice studies focused on different parts of the implementation pathway. Two dealt with implementation of IT systems to support detection of potentially hazardous prescribing[12, 13]; one was a process evaluation of the PINCER trial[11]; and one focused on implementation of structured medication reviews as recommended by NHS England in routine practice[14]. The studies of IT-supported interventions were broadly positive about the potential for implementation and sustainability, but the study of NHS England's SMR programme concluded that its early implementation failed to deliver the planned holistic and patient-centred approach.

Other evidence

Conference abstracts

We included 11 conference abstracts (Table 4), of which two were earlier reports of studies subsequently published as full papers[28, 30]. All of the included abstracts focused on intervention effects on prescribing and related outcomes.

Five abstracts reported research in general practice, of which three involved patients with polypharmacy identified from the overall practice population[31-33]. As a group, these three abstracts provided weak evidence of associations between pharmacist-led medication reviews and changes in medication and cost savings together with high levels of patient satisfaction (Table 3),

Two abstracts reported on selected general practice populations. The only comparative study in this group reported that patients living with frailty who were reviewed by a pharmacist as part of a multi-disciplinary team review had a reduction in total medications compared with a control cohort[34]. When patients recently discharged from hospital were reviewed by a pharmacist working in their general practice, 16 out of 35 had changes made to their medication, with 74% of changes involving deprescribing[35].

Turning to studies performed in care homes, two abstracts by Doherty et al. (2020)[36, 37] evaluated an intervention entitled Medicines Optimisation in Older People (MOOP) which involved case management by pharmacists. The authors reported that inappropriate prescribing (based on the MAI) was highly prevalent at baseline *84%) but declined significantly following the intervention. Swift et al. reported that a team comprising pharmacists and pharmacy technicians who both performed medication reviews and supported care home staff significantly reduced inappropriate polypharmacy (measured by prescribing quality indicators) between 2024 and 2017[38]. For care home residents receiving palliative care, structured medication reviews involving shared decision-

Grey literature case studies

We included reports of four case studies reporting on local initiatives in three areas of England (see Table 4). Details of all case studies may be found in Annex C of the National Overprescribing Review report[1]. Case studies were submitted by NHS organisations (mainly CCGs) and included varying amounts of data on intervention characteristics, support for implementation and outcome measures. Three interventions were delivered in general practice and one in care homes. The initiative developed by Swale CCG was distinctive in using pharmacy technicians to review less complex cases, although the initiative was targeted at patients considered high-risk for ADRs. Although not classified as research, such case studies can provide useful data on implementation of interventions and outcomes achieved in routine practice



Table 3: Summary of studies published as conference abstracts

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Table 3: Summa	ry of studies published a	as conference abstracts		bmjopen-2023-081934 on 7
Reference	Population	Intervention	Study design	Outcome measuges and key findings
Alves 2016[28]	Care home residents	Medication review by primary care pharmacists linked to GP practices	Service evaluation (retrospective analysis and interviews)	Interventions by 胸横横macist; barriers and facilitators A total of 2916 i强重要ntions were made in 1047 patients, of which depresented 22%
Bryant 2019[31]	Primary care patients taking ten or more medications	Polypharmacy clinics in GP surgeries	Service evaluation (retrospective data analysis)	Reductions in property ing; cost savings; hospital admissions avoiding a pril 2017 to March 2018, 370 patients reviewed and £50,766.63 save to the pril to December 2018 were 209 and £13,862, respectively
Chauhan 2022[35]	Patients recently discharged from hospital	Post-discharge medication review by clinical pharmacist linked to GP practice	Formative service evaluation (uncontrolled)	Medication change following review 16/35 patients had medications changed; 74% (25/34) of changes were medications stopped
Din 2020[32]	Patients referred by GPs	Polypharmacy review clinics led by pharmacist independent prescriber with shared decision-making	Service evaluation (uncontrolled)	Changes to medication, feedback from patients and MDT Pharmacist medication reviews were effective, with positive feedback received from patients and members of the MDT. Deprescribing and inhaler counselling were the most common interventions.
Din 2022[34]	Primary care patients living with frailty	Frailty review involving pharmacist as part of MDT	Comparative cohort	Changes in medigation (including cholinergic burden), practice contacts and falls Intervention group had a reduction in total number of medications when compared with non-intervention cohort. Anti-cholinergic burden scores were reduced by a mean of 26%
		For peer review only - http://br	njopen.bmj.com/site/abo	ibliographique de

			BMJ Open	bmjopen-2023-
Doherty 2020a[36], 2020b[37]	Care home residents	Medicines Optimisation in Older People (MOOP) involving case management by pharmacists	Uncontrolled before/after	Inappropriate prescribing; unplanned hospital admissions; GP visits; clinical interventions Inappropriate prescribing was highly prevalent at baseline (84.1%) but improver significantly from baseline (M = 14.87, SD = 13.1% post-intervention (M = 0.70, SD = 2.04, Z = 25.97, procedure)
Donyai 2017[33]	Patients aged at least 75 years and prescribed 15 or more medication	Pharmacist-led polypharmacy review clinic in primary care	Survey	Patient satisfaction of the 166 patient satisfaction questionnaire (46%) sponse rate), 83% found the service helpful, 13% did not know and 2% did not respond
Kolovetsios 2018[39]	Care home residents needing palliative care	Structured medication reviews carried out in agreement with patient, nurse, family/carer and GP	Service evaluation	Changes to medication, estimated cost savings From January 20 20 January 2018, 574 medication reviews took place gresulting in 1787 suggested medication changes. Approximately 76% of these changes were agreed and pactioned by patients' GPs, with estimated savings of 169,986.96.
Swift 2018[38]	Care home residents	Care home team (pharmacists and pharmacy technicians) delivering medication reviews and supporting care home staff	Service evaluation	Prescribing quality indicators (including reduced inappropriate polypharmacy); CQC ratings Medication reviews were completed for 749 care home residents between Agust 2014 and March 2017. Of the recommendations made to prescribers, 85% were accepted and resulted in a reduction in inappropriate polypharmacy
Syafhan 2019[30]	Patients in participating GP practices at risk of MRPs	Pharmacist-supplemented care focusing on medication optimisation	Individual RCT	Number of medication related problems (MRPs) and medication inaparopgateness A total of 356 addit partients (175 control and 181 intervention) were regruited. Among 108 intervention patients who had three pharmacist face-to-face contacts, 346 MRPs were identified at baseline and 83 MRPs at 6 months. Median values were 3 MRPs at baseline and 1 at 6 months (p<0.001).

Table 4: Summary of selected grey literature case studies

		BMJ Open	bmjopen-2023-081934
Table 4: Summar	ry of selected grey literature	case studies	mjopen-2023-081934 on 7 by copyright, including fo
Setting	Name of initiative	Key findings	Comments &
Brighton and	An evaluation of a clinical	A total of 1,300 patients were referred into the service	The targe fatient cohort of frail or older
Hove CCG	pharmacist medication review service in primary care	and reviewed between April 2017 and March 2018; 9% of patients were deprescribed high-risk medicines	person received polypharmacy was identified from sea received within GP clinical systems and through received from clinical practitioners,
Swale CCG	Medicines Optimisation Review Programme	In 2018/19, pharmacists and pharmacy technicians reviewed 5281 patients and made 3859 interventions, 37% for adverse drug reactions (ADRs). Estimated inyear cost savings were £239,546	voluntagy and social care services Targeted at the high-risk' patients Key feature at the cases at 1 AB and 1
NE Hampshire and Farnham CCG	Care homes pharmacist	Pharmacist accompanying GPs visiting care homes carried out over 250 medication reviews and 800 interventions. Average number of medicines per resident fell from 9.4 to 7.6	Limited Pareported Limited Pareported O, Al training in the control of the cont
NE Hampshire and Farnham CCG	Polypharmacy prescribing comparators	Tool developed by Wessex AHSN was used to identify patients at risk of harm, resulting in significant reductions in percentage of patients aged over 75 prescribed 15 or more medications and percentage with an anticholinergic burden score of 6 or more	Limited reported
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			\gence Bibliographique de
	Fo	r peer review only - http://bmjopen.bmj.com/site/about/guidel	ines.xhtml —

Study quality

Quality assessment results using the MMAT are presented in Appendix Table 3 (see supplementary files). The results should be read in conjunction with the study strengths and limitations (see Appendix Table 1 (see supplementary files).

Five different checklists within the MMAT were used to assess the 14 studies. The sample included one RCT[17]; six studies were classified as quantitative non-randomised[15, 16, 19, 20, 23, 24]; one as quantitative descriptive[11]; one as mixed methods[21]; and five as qualitative[12-14, 18, 22]. All studies passed the screening questions (are there clear research questions? and do the collected data allow to address the research questions?)

The RCT by Syafhan et al. was described as a pragmatic trial and was at relatively high risk of bias for this type of design. The trial did not achieve the planned number of participants and there was a high rate of attrition (about 30%), meaning that many participants did not receive the full intervention or provide outcome data. The trial also suffered from unclear reporting: method of randomisation and whether outcome assessors were blinded was not reported, making it difficult to assess overall risk of bias.

The quantitative non-randomised studies comprised four observational studies at high risk of bias because of the absence of a control group[19, 20, 23, 24] and two large ITS studies[15, 16]. The MMAT tool identified some limitations of these studies, including some risk of confounding and incomplete outcome data in one study[16]. However, these were large studies conducted in routine practice and providing evidence of a statistically significant effect at 12 months post-intervention. The process evaluations of the CHIPPS[21] and PINCER[11] studies both scored highly on the MMAT assessment.

The qualitative studies were generally of good quality, with sufficient data presented in support of conclusions and appropriate use of frameworks and thematic analysis to organise presentation of the findings. The study by Alharthi et al.[18] was a secondary analysis of data collected for another purpose, making it unclear whether qualitative data collection methods were adequate.

Using the system applied by the authors in previous studies of complex health service interventions[10], the overall strength of evidence was classified as borderline 'stronger' (generally consistent findings in multiple studies with a comparator group) for general practice, 'weaker' (generally consistent findings in one study with a comparator group design and several non-comparator studies or multiple non-comparator studies) for care homes and 'very limited' (single study) for community pharmacies.

Effectively implemented interventions

Three research studies met the criteria for 'effectively implemented' interventions: the closely related PINCER[16] and SMASH[15] interventions in general practice and the Somerset model of medication review in care homes[19]. Further examples of effectively implemented medication review in care homes were identified among the included conference abstracts[36-39]. Case studies from Brighton and Hove and Swale CCGs appeared to report effectively implemented interventions

targeted at high-risk patients in general practice (Table 5). An evaluation of the early implementation of SMRs in primary care networks indicated that the service as provided did not match the vision of a patient-centred holistic review with an emphasis on shared decision-making[14].



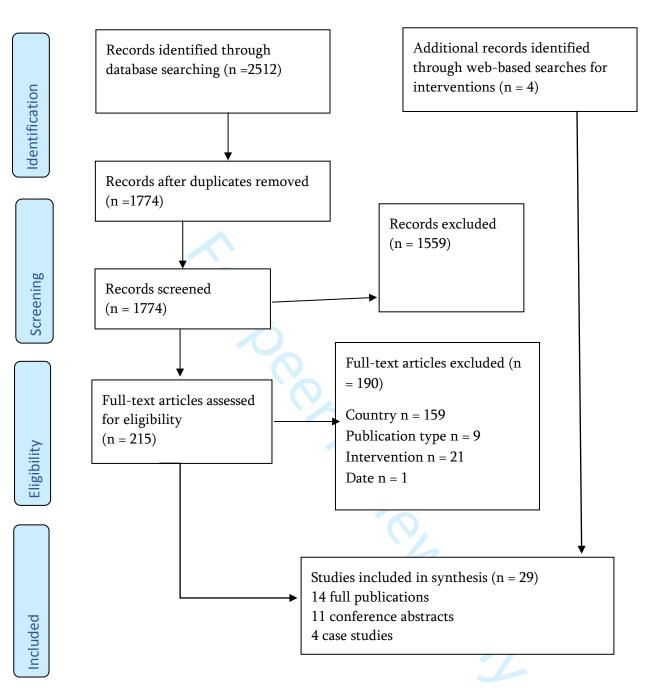


Figure 1 PRISMA Flowchart

.Discussion

Summary of findings

In spite of its broad inclusion criteria, this review identified a relatively small number of studies of pharmacist-led interventions in UK primary care (14 peer reviewed journal articles, 11 conference abstracts and four case studies). Overall, the bulk of evidence came from the care home sector but most of the better quality evidence was derived from studies conducted in general practice. The majority (8/14) of peer reviewed papers were published in 2020 or later, suggesting that this is a developing area of research and practice in the context of encouraging patients to consult pharmacists initially for minor conditions and to increase pharmacists' prescribing rights. It was encouraging that we identified a number of effectively implemented interventions and initiatives in both care homes and general practice.

Outcomes of effective interventions

This systematic review suggests that pharmacist-led interventions may reduce overprescribing in primary care settings in the UK. The evidence is strongest for interventions implemented in general practice, where we identified a small randomised trial[17] as well as two large quasi-experimental studies (interrupted time series)[15, 16] and various uncontrolled studies and service evaluations. Evidence from care home settings was of lower quality with the exception of the CHIPPS study involving pharmacist independent prescribers working in care homes[21]. We located only one uncontrolled study based in UK community pharmacies[24].

Although the direction of reported effects was clear, the limited number of studies combined with the wide range of outcomes reported makes it difficult to estimate the size of any effect. For example, the two ITS studies using similar interventions reported markedly different reductions in measures of inappropriate prescribing at 6 and 12 months after implementation of the intervention[15, 16]. Uncertainty about effect sizes is increased because many of the studies lacked a control group and the results could have been influenced by other interventions in the health and social care system, for example the Enhanced Health in Care Homes programme implemented in England. While our review focused primarily on outcomes related to prescribing, data on cost savings were also widely reported but the evidence was generally of low quality. We also found limited evidence of a link between reductions in measures of overprescribing and clinical outcomes, mainly because of lack of reporting. The CHIPPS study found no significant difference in its primary outcome of fall rate, although there was a reduction in Drug Burden Index (a secondary outcome) in the intervention group at 6 months[29].

Characteristics of effective interventions

The TIDieR Lite checklist provided a suitable structure for describing intervention characteristics for evidence synthesis purposes and this discussion follows its structure. Lack of reporting (especially of intervention intensity/frequency) was a limiting factor, as was reporting of varying intervention information across multiple publications.

Medication reviews were undertaken by pharmacists acting independently or in conjunction with GPs or care home staff. In a study in care homes for people with intellectual disabilities, psychiatrists were also involved in review where appropriate[23]. Pharmacy technicians were also involved in the PINCER study and could potentially have a greater role in relatively straightforward medication reviews[11, 16]. The included studies reported a variety of models of employment of pharmacists, including direct employment by GP practices, CCG Medicines Optimisation Teams, PIPs and community pharmacists. PCNs support employment of pharmacists by general practices and are the route chosen by NHS England to implement its model of SMR.

A major difference between settings is the need to identify patients requiring medication review in general practice, whereas most care home residents take multiple medications and could be considered candidates for review as part of their routine health care. A key element of the PINCER[11, 16] and SMASH[15] interventions is the use of information technology to search electronic patient records efficiently across large numbers of general practices. Effective interventions were also characterised by attention to training and tools to support and sustain change in practice, e.g. an 'audit and feedback' dashboard[15].

Training of pharmacists and other staff to deliver interventions was reported to varying degrees, reflecting in part the publication channel of the research. For example, in the CHIPPS study PIPS had comprised 2 days of face-to-face instruction plus time in practice to develop relationships with the GP and care home staff. [21] Specification and provision of appropriate training will be important for future development of pharmacist-led interventions, as also highlighted by the evaluation of NHS England's SMR programme [14].

Intervention intensity is another important factor in developing and delivering interventions. For the CHIPPS study, participating PIPs committed a minimum of 16 hours/month to the service. [21] In general practice settings, NHS England recommended allowing 30 minutes for an SMR to give time for shared decision-making; this was interpreted to include time for preparation and writing-up[14]. This level of time requirement was also reported in the one study from a community setting, which estimated pharmacist time at 25 minutes for an initial consultation[24].

In terms of intensity more generally, resourcing of interventions was reported to vary between commissioning groups (CCGs) depending on staff availability and other priorities[11, 16, 19]. General practices varied in their use of a medication safety dashboard[26]. Frequency of intervention was rarely reported, reflecting the short time frame of most included studies but it seems possible that there could be an ongoing need for review as patients get older and/or their health state changes.

Quality and risk of bias

The MMAT provided a good alternative to the use of multiple tools to assess risk of bias across diverse study designs. The only randomised trial assessed was designed as a pragmatic trial[17] and the assessment confirmed a relatively high risk of bias. Publications from the CHIPPS study were included but the trial *per se* was not assessed for risk of bias because of the publication date of the main study report. Similarly, the PINCER intervention was supported by a randomised trial published in 2012, before the cut-off date for our review [40]). Well-conducted studies included in the review included large ITS studies[15, 16], process evaluations[11, 12, 21] and qualitative studies[13, 14]. Service evaluations and other lower quality evidence tended to support higher quality studies by highlighting implementation and results achieved in routine practice, although a causal relationship between intervention and outcome remains uncertain in studies without a parallel control group.

Implementation barriers and facilitators

Implementation of pharmacist-led interventions was strongly influenced by factors affecting relationships between pharmacists and other health and care professionals, especially GPs. Given that most pharmacists are not prescribers, their recommendations around (de)prescribing need to be seen as 'legitimate' by GPs who are generally responsible for acting on the recommendations. This is facilitated by continuity at the system level, including existing links between pharmacists and GPs[21] and good access to data[12]. Jeffries et al. reported that pharmacists took the lead in developing relationships with GPs, enabling a 'learning health system'[12]. The benefits of continuity at the system level could help to explain why early implementation of the SMR programme through the relatively new medium of PCNs was reported to be less successful than initially hoped[14].

Implementation in care homes may be more complex than in general practice because of differences in systems and 'culture' between health and social care[22]. Patients and their families may be supportive of medication review or oppose it based on real or perceived benefits of medication[18].

The main message regarding implementation of pharmacist-led interventions across all settings is the need for involvement of all relevant stakeholders, preferably before starting the process of implementation, to understand the context and anticipate possible barriers[22].

Identification of effectively implemented interventions/initiatives:

Our simple criteria for 'effectively implemented' interventions/initiatives identified a number of examples published as research papers, conference abstracts or case studies (see 'Effectively implemented interventions' above). Despite limitations as research, some of the abstracts and case studies provided valuable information about how commissioners and providers had supported interventions and their commitment to continue the programme[36-39]. In other studies, despite promising results, it was unclear whether the intervention would be implemented more widely[17].

Relationship to previous research

To our knowledge, this is the first systematic review of pharmacist-led interventions and initiatives specifically in UK settings. A scoping review of reviews by the same authors (Preston et al., in preparation) included 20 systematic reviews published between 2014 and 2023. The most recent review covered pharmacist integration into general practice to optimise prescribing and outcomes for patients with polypharmacy[41]. The review included 23 studies, of which just three were from the UK. The conclusion that pharmacist integration probably reduced PIP and number of medicines (moderate certainty evidence) was in line with the findings of the present review.

Strengths and limitations

The UK focus is both a strength and limitation of this review. We included evidence often excluded from systematic reviews to get as full a picture as possible of how pharmacist-led interventions are implemented and sustained in practice as well as their characteristics and effectiveness. The dual focus reflects the fact that pharmacist-led medicines optimisation and deprescribing in primary care is both an area of active research and of implementation within the health care system. Nevertheless, some of the evidence is not of high quality and we have tried to be appropriately cautious in our conclusions and identified implications.

Our broad review questions and UK focus resulted in a heterogeneous group of included studies. Meta-analysis was not possible so we performed a narrative synthesis in line with appropriate guidelines[8, 9]. The review was undertaken by a small but experienced team with expertise in systematic review methods and prescribing.

Implications for service delivery

Several studies indicate that barriers to successful service delivery often arise from 'system' issues and differences in 'culture' [14, 22]. Commissioners and providers engaged in developing new pharmacist-led services should ensure equitable access to data and information to avoid perceptions of 'ownership' by certain groups at the expense of others [13]. In care homes, where medication review is an important component of health care for residents [19], implementation requires health and social care professionals to work together and 'understand each other's systems' [22]. The holistic patient-centred SMR envisaged by NHS England may require culture change/training to foster an emphasis on direct patient contact and shared decision-making. Removal of financial incentives for PCNs to carry out SMRs as reported recently (https://pharmaceutical-journal.com/article/news/nhs-england-removes-financial-incentives-for-structured-medication-reviews-in-2023-2024) may complicate delivery, although the service remains a contractual requirement.

Services have been delivered successfully through CCGs Medicines Optimisation Teams with suitable training[11, 16]. The review also found evidence that services provided by PIPs appear to be a valid alternative to approaches requiring action by GPs or other medical professionals[21].

Implications for research

A major priority for research is to further evaluate the effectiveness of medication review in community pharmacy settings and how pharmacies might be best supported to deliver the service. A related need is for research to better understand public perceptions of community pharmacies as a setting for medication review and their pros and cons compared with alternative settings such as GP surgeries. Research is needed to support the development of the PIP role and how PIPs might best be used in combination with GPs and other professionals to support optimal prescribing across the health and care system.

Shared decision-making is key to the success of pharmacist-led interventions. Qualitative research is needed to better understand patient and family attitudes to shared decision-making in the context

of deprescribing and the barriers and facilitators operating in different settings and with different professionals.

The present review focused on outcomes related to prescribing and a review of effects on patient and health system outcomes would be a logical follow-up, as would further review work to address any gaps identified by the accompanying review of reviews (Preston et al. in preparation). Finally, further research is needed to understand the effects of implementing pharmacist-led medication review in general practice on health inequalities and how to reduce unwarranted variations in service delivery between different practices or regions.

Conclusions

Pharmacist-led interventions have demonstrated the potential to reduce overprescribing in primary care settings in the UK. The evidence base varies widely in terms of quality but studies have consistently reported improvements relative to a comparator group or baseline. The diversity of interventions and outcomes reported makes it difficult to generalise about effect sizes but given the reported extent of the problem, even small relative reductions could be highly beneficial for patients and the health and care system.

The existing evidence base requires cautious interpretation because of a shortage of controlled studies and this is particularly the case for studies in community pharmacy settings. Further rigorous evaluation of interventions, particularly those delivered in community pharmacies, is required. Although not a focus of this review, there appears to be a shortage of high-quality economic evidence to guide decision-making.

The problems encountered in the early implementation of NHS England's SMR programme[14] suggest a need for further research on the implementation of pharmacist-led interventions. Implementation of this type of interventions requires the involvement of all relevant stakeholders, preferably before starting the process of implementation, to understand the context and anticipate possible barriers.

Funding

 This work was supported by the National Institute for Health and Care Research (award ID NIHR 135767). The funder had no role in drafting the paper or approving the version to be submitted

Conflict of interest

The authors have no conflicts of interest to declare.

Disclaimer

This report presents independent research funded by the National Institute for Health and Care Research (NIHR). The views and opinions expressed are those of the authors and do not necessarily reflect those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health. and Social Care.

Contribution of authors

Duncan Chambers contributed to all review processes and wrote the first draft of the paper. Louise Preston managed the review team, and contributed to all review processes and to writing the paper. Mark Clowes developed search strategies, performed literature searches and contributed to writing the paper. Anna Cantrell contributed to all review processes and to writing the paper. Elizabeth Goyder provided topic expertise and contributed to writing the paper. All authors have approved the version to be submitted.

Data sharing

Any additional data not included in this report and its appendices are available on request. All queries should be submitted to the corresponding author.

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Data extraction tables

Table 1: Study characteristics of included research studies (full data extraction table)

	raction tables Study characte	ristics of incl	uded research	BMJ Open studies (full data extraction tal	bmjopen-2023-081934 on 7 August 2024. Do Enseignement d by copyright, including for uses related to	
Study ID	Study design/sample size	Setting	Intervention	Key findings	Authors' conclus Bes	Study strengths/limitations
Alharthi 2023[18]	Secondary analysis of qualitative interview data 11 pharmacist independent prescribers (PIPs) who participated in a cluster randomised trial	Care homes in England and Scotland	Integration of PIPs into care homes to improve medication management	Factors that acted as both enablers and barriers were PIP relationship with General Practitioner (GP), care home staff and residents/families, awareness of the PIP role and family trust in PIPs' deprescribing activities (social influences); PIPs' independent prescribing confidence, previous experience and ability dealing with residents' medications (beliefs about capabilities); understanding of PIP role and PIP confidence in their role as an independent prescriber (social/professional role and identity); access to residents' records, deprescribing decision support, regular follow-up from care home staff, resident	PiPs' involvement is influenced by influence be addressed to limit open.bmj.com/ on June 9, 2025 at Agence Bibliogram in technologies.	Strengths: Diverse PIP contexts and perspectives on deprescribing; theory-informed analysis using Theoretical Domains Framework to identify barriers and enablers Limitations: Only PIP perspective considered; analysis used data from interviews focused on the whole intervention process rather than exclusively on deprescribing

				difficulties with medications, teamwork, and time restraints (environmental context and resources). Belief that the negatives of deprescribing outweigh benefits regarding certain medications (beliefs about consequences) acted as a barrier.	081934 on 7 August 2024. Dov Enseignement including for uses related to t	
Alves 2019[19]	Service evaluation 10,405 patient reviews over 5 years	Care homes in Somerset	Medication review by primary care pharmacists linked to GP practices	Pharmacists made 23,955 interventions (mean 2.3 per patient) from the 10,405 patient reviews undertaken. 16.1% of interventions were related to safety. Potential drug cost savings were estimated at £812,441 over 5 years, of which £431, 493 (53%) was attributed to deprescribing	Medication reviews aundertaken by primary care a wide range of interventions, commonly involving deprescribing. He service contributes to the continuous optimisation of prescribing and monitoring of reeding cost savings.	Strengths: Collection of data from 'real world' implementation of intervention over 5 years Limitations: No control group, cost saving estimates not based on full economic evaluation
Baqir 2017[20]	Retrospective evaluation of quality improvement project 422 residents in 20 care homes	Care homes in two CCG areas in North East England	Medicines optimisation by a pharmacist acting independently or jointly with a GP. Shared decision making with the patient or their advocate	Of the 422 patients reviewed, 298 (70.6%) had at least one medicine deprescribed with 704 medicines (19.5%) being stopped. There was no statistically significant difference between pharmacist only and pharmacist plus GP in terms of deprescribing. Assuming that each medicine stopped would have been taken for another	Medicines optimisation reviews can lead to a reduction in polypharmacy for care home residents through a complete deprescribing coccess. Patients' medicine regiments were simplified and optimised while making financial sagings for the NHS	Strengths: Compares two approaches to delivering medication review Limitations: Short-term uncontrolled study; intervention quality/fidelity not measured

Were estimated at £65,471 Simple Were esti					BMJ Open	omjopen-2	
arm comprised 25 triads: Care homes (staff and up to 24 residents), GP and pharmacist Independent Prescriber (PIP); 22 PIPs contributed data management management having time to engage with care home staff and residents during reviews. PIPs recorded 566 clinical interventions, many involving deprescribing; 93.8% of changes were sustained at 6 months. For 284 (50.2%) residents, changes involved a medicine linked to increased falls risk. Qualitative data indicated participants noted increased medication safety and improved resident quality of life. Contextual barriers to implementation were apparent in the few triads where PIP was not known to the GP and care home before the trial. In three triads, PIPs did not deliver the intervention.	•	methods process evaluation of cluster RCT Intervention arm comprised 25 triads: Care homes (staff and up to 24 residents), GP and pharmacist Independent Prescriber (PIP); 22 PIPs contributed	in England, Scotland and Northern Ireland tervention m comprised of triads: Care omes (staff and up to 24 sidents), P and narmacist dependent rescriber IP); 22 PIPs ontributed	PIPs into care homes to assume central responsibility for medicines	were estimated at £65,471 All stakeholders reported some benefits from PIPs having responsibility for medicine management and identified no safety concerns. PIPs reported an increase in their knowledge and identified the value of having time to engage with care home staff and residents during reviews. PIPs recorded 566 clinical interventions, many involving deprescribing; 93.8% of changes were sustained at 6 months. For 284 (50.2%) residents a medicine was stopped, and for a quarter of residents, changes involved a medicine linked to increased falls risk. Qualitative data indicated participants noted increased medication safety and improved resident quality of life. Contextual barriers to implementation were apparent in the few triads where PIP was not known to the GP and care home before the trial. In three	implemented as intended, and well-received by the stakeholders. The stakeholders. The stakeholders. The stakeholders are stakeholders are stakeholders. The stakeholders are stakeholders are stakeholders. The stakeholders are stakeholders are stakeholders are stakeholders are stakeholders. The stakeholders are stakeholders a	Strengths: Involved three UK nations with differing healthcare systems; used study records to supplement qualitative data Limitations: Interview participants may not be representative; limited access to care home residents

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2014[11] eval data clus 36 inte and prace pati ider risk inte	ervention d 36 control actices; 1946 tients entified as at	General practice surgeries in an 80 km radius around Manchester and Nottingham	Pharmacist-led IT enabled intervention (PINCER). Patients potentially at risk from hazardous medicines management were identified using Quest Browser software to search GP electronic records. Intervention practices were assigned a pharmacist who educated practice staff about medication management and recommended improvements to practice. Pharmacists	Pharmacists judged 72% (95% CI 70, 74; 1463/2026) of cases of hazardous medicines management to be clinically relevant. Pharmacists recommended 2105 interventions in 74% (95% CI 73, 76; 1516/2038) of cases and 1685 actions were taken in 61% (95% CI 59, 63; 1246/2038) of cases; 66% (95% CI 64, 68; 1383/2105) of interventions recommended by pharmacists were completed and 5% were accepted by GPs but not completed at the end of the pharmacists' placement; the remaining recommendations were rejected or considered not relevant by GPs.	Recommendation by the pharmacists wend specific to ameliorative acceptable to ameliorative acceptable to ameliorative acceptable by the PINCER pharmacists will be employed by the PINCER pharming and data mining, Al training, and similar technologies. Recommendation the majority of cases by the PINCER pharming and data mining, Al training, and similar technologies.	Strengths: Uses dat from a large cluster RCT Limitations: Pharmacists did not record detailed reasons for their judgements and these were not peer reviewed

	bmjopen-2023. BMJ Open BMJ Open									
Jeffries 2017[13]	Qualitative realist evaluation	CCG in the South of England	cases of potentially hazardous medication and recommended interventions to GPs Electronic Medicines Optimisation System	Effective use of the EMOS depended upon engagement with the system, the flow of information between different	by copyright, including for uses related to the medicines option and improve may improve may improve may care an imprimary care at the may improve may	Strengths: Realist methodology enabled detailed examination of how				
	Interviews: 3 GPs, 2 CCG pharmacists; Focus groups: 2 GPs, 4 community pharmacists, 4 patients, 4 practice managers		(EMOS). The EMOS is intended to facilitate clinical audits of prescribing activity to identify patients at risk of adverse drug events (ADEs)	health professionals centrally placed at the CCG and those locally placed at individual general practices, and upon adaptation of work practices to facilitate the use of the system. The use of the system was undermined by perceptions of ownership, lack of access, lack of knowledge and awareness, and time pressures.	identifying those adjents at risk of an ADE. To feeling ealise the potential beneals there needs to be better utilisation across promary care and with a wider range of stakeholders. Engaging with all potential stakeholders and users prior to implementation might allay perceptions that the system is owned coeptrally and increase knowledges of the potential beneals.	the EMOS was used and its potential effects Limitations: Study involved only one CCG so may not be representative				
Jeffries 2018[12]	Qualitative process evaluation 28 staff members from 23 general practices (9	43 general practices in Salford, Greater Manchester	Electronic audit and feedback surveillance dashboard to identify patients potentially at	Engagement with the dashboard involved a process of 'sensemaking' by pharmacists. The intervention helped to build respect, improve trust and develop relationships between pharmacists and GPs. Collaboration and	Medicine optingsation in primary care may be enhanced by the implementation of a pharmacist-led elegronic audit and feedback system. This intervention estable hed a rapid learning health system that enabled data from electronic	Strengths: Use of Normalization Process Theory as a framework to understand implementation				

	CD: 43	T			5 <u>8</u>	11
	GPs, 12		risk of	communication between	health records to	Limitations:
	pharmacists, 7		hazardous	pharmacists and clinicians was	make changes 🛱 practice to	Evaluation team als
	other GP staff)		prescribing or	primarily initiated by	improve patien care.	developed the
			monitoring of	pharmacists and was important	_ A	intervention; numb
			medicines	for establishing the intervention.	August Ense r uses r	of follow-up
					s reig	interviews was
					2022 Jine late	limited
Lane	Qualitative	Care homes	Integration of	A PIP service was seen as	The overarching the from this	Strengths:
2020[22]	focus groups	(4 sites in	PIPs into care	offering benefits for residents,	research was that everyone	Purposively selecte
	and interviews	England (2),	homes to take	care homes and doctors but	must "understa 🕳 🕏 ch other's	sample; use of TDF
		Scotland	responsibility	stakeholders raised challenges	systems". In particular, PIPs	a framework to
	85 (72 in focus	and	for medicines	including agreement on areas	need to unders இத்தின் care homes'	analyse data
	groups and 13	Northern	management	where PIPs might prescribe,	systems in adva to the systems in adva to the systems in adva to the system in advantage in a system	,
	in semi-	Ireland)		contextual barriers in chronic	implementing argust service	Limitations: Data
	structured	,		disease management, PIPs'	=:3 <u>-</u>	relate to proposed
	interviews)			knowledge of older people's	p://bmjopen.bmj.com/ on June 9, 2025 and similar technologies	service model in
				medicine, and implementation	l tr	advance of
				barriers in integrated team-	ain	implementation
				working and ensuring role	ing n.b	Implementation
				clarity. Introducing a PIP was	a nj.	
				welcomed in principle	i pr	
				but conditional on: a clearly	sim v	
				defined PIP role communicated	ilan on .	
					Jur te	
				to stakeholders; collaboration	chr 9	
				between doctors, PIPs and care-), 20	
				home staff; and dialogue about)25 ogie	
				developing the service with	es.	
		_	_	residents and relatives.	A	
Madden	Qualitative	General	Structured	SMR implementation was largely	Early implementatign of SMRs	Strengths: based or
2022[14]	interview	practice in	medication	delegated to individual	did not match the intention of	detailed, in-depth
	study	England	review (SMR)	pharmacists. Established	providing patients with a holistic	interviews
			for people at	pharmacists appeared more	review and shared @ ecision-	
			risk of harm or	ready for implementation than	making. The autho	

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	10 newly appointed pharmacists working in primary care networks (PCNs) in Northern England; 10 established pharmacists working in GP practices in other PCNs		medication- related problems	newly appointed staff. New pharmacists were learning about working in primary care settings and tended to follow procedures with which they were already familiar, particularly when they lacked patient-facing expertise. Implementation was affected by ongoing backlogs and workforce issues in general practices	an important opposition of SMR implementation of SMR implementation of section of sectio	Limitations: Authors note interviews nee to be complemented by data on actual practice and longer term follow-up
Peek 2020[15]	Interrupted time series 43 general practices covering 235,595 people in Salford, Greater Manchester	General practice in England	Pharmacist-led Safety Medication dASHboard (SMASH). SMASH involved (1) training of clinical pharmacists to deliver the intervention; (2) a web- based dashboard providing actionable, patient-level feedback; and	The study used an interrupted time series analysis of rates (prevalence) of potentially hazardous prescribing and inadequate blood-test monitoring, comparing observed rates post-intervention to extrapolations from a 24-month pre-intervention trend. At baseline, 95% of practices had rates of potentially hazardous prescribing (composite of 10 indicators) between 0.88% and 6.19%. The prevalence of potentially hazardous prescribing reduced by 27.9% (95% CI 20.3% to 36.8%, p < 0.001) at 24 weeks and by 40.7% (95% CI 29.1% to 54.2%, p <	The SMASH intervention was associated with reduced rates of potentially hazardous prescribing and intervention was sustained over a contract of medication. The was a marked reduction if the variation in rates of prescribing between practices. Agence Bibliogra	Strengths: Authors noted pragmatic design, evaluation or clinically relevant outcomes and large number of practices taking part Limitations: Not a randomised study so possibility of unrecognised confounding cannot be excluded

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Rodgers 2022[16] Multiple interrupted time series 393 general practices covering approximately 3 million patients	General practice in the East Midlands region of England	pharmacists reviewing individual atrisk patients, and initiating remedial actions or advising GPs on doing so. Pharmacist-led IT intervention to reduce hazardous prescribing (PINCER)	0.001) at 12 months after introduction of SMASH. The rate of inadequate blood-test monitoring (composite of 2 indicators) reduced by 22.0% (95% CI 0.2% to 50.7%, <i>p</i> = 0.046) at 24 weeks; the change at 12 months (23.5%) was no longer significant (95% CI –4.5% to 61.6%, <i>p</i> = 0.127). After 12 months, 95% of practices had rates of potentially hazardous prescribing between 0.74% and 3.02%. Successive groups of general practices received the PINCER intervention between September 2015 and April 2017. Eleven prescribing safety indicators were used to identify potentially hazardous prescribing and data were collected over a maximum of 16 quarterly time periods. PINCER was implemented in 370 (94.1%) of 393 general practices:	The PINCER integral associated with a reduction by the seribing were the seribing were the seribing were the seribing support the wider national serion as sociated with the serion as support the wider national serion as seribing the serion as support the wider national series as seribing the serion as series as support the wider national series as series as series as series as support the wider national series as ser	Strengths: Suggests intervention was implemented successfully in routine practice and was associated with significant reductions in hazardous prescribing Limitations: The
approximately 3 million			prescribing and data were collected over a maximum of 16 quarterly time periods.	reductions in hazargous prescribing were for indicators associated with grisk of GI	in hazardous

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Syafha 2021[1	7] 356 patients at risk of medication-related	General practice in England (6 practices) and Northern	Medicines optimisation with shared decision- making and agreed	16.7% (adjusted odds ratio (aOR) 0.83, 95% confidence interval (CI) 0.80 to 0.86) at 6 months and 15.3% (aOR 0.85, 95% CI 0.80 to 0.90) at 12 months post-intervention. The unadjusted rate of hazardous prescribing reduced from 26.4% to 20.1% at 6 months and 19.1% at 12 months. The greatest reduction was for hazardous prescribing indicators related to GI bleeding Median number of MRPs per intervention patient at 6 months was reduced from 3 to 0.5 (p < 0.001) in patients who received the full intervention schedule. Medication Appropriateness	n-2023-081934 on 7 August 2024. Downloaded from the Enseignement Superieur (ABLS) at the pharmacistic medications and temperal practice in a cost-effecting	have been influenced by unknown confounding factors or behavioural changes unrelated to the PINCER intervention. Data were also not collected for all practices at 6 and 12 months post-intervention Strengths: Pragmatic randomised design Limitations: Sample smaller than planned; high loss to
	problems (MRPs) from 8 GP practices	Ireland (2)	treatment goals. Intervention repeated at 2 and 4 months, building on progress towards agreed goals	Index (MAI) scores were reduced (medications more appropriate) for the intervention group, but not for control group patients. Using the intention-to-treat (ITT) approach, the number of telephone consultations in intervention group patients was reduced and different from the control group. No significant differences between groups were found in unplanned hospital admissions, length of	mj.com/ on June 9, 2025 at Agence Bibliographique de I , and similar technologies.	follow-up; MRP analysis only covered patients who attended 3 appointments

hospital stay, number of A&E attendances or outpatient visits. The mean overall healthcare cost per intervention patient fell from £1041.7 ± 1446.7 to £859.3 ± 1235.2 (p = 0.032). Cost utility analysis showed an incremental cost per patient of – £229.0 (95% CI –	on 7 August 2024 Enseigner g for uses relate
Service evaluation Thayer 2021[23] The proper intellectual disabilities (ID) Service evaluation The proper intellectual disabilities (ID) Service evaluation The proper interventions intellectual disabilities (ID) The proper interventions intellectual disabilities (ID) The proper interventions intellectual disabilities (ID) The proper interventions interventions interventions interventions interventions intervention (30.4%) were interventions interventions intervention (30.4%) were interventions intervention (30.4%) were intervention (30.4%) were intervention intervention (30.4%) were intervention intervention (30.4%) were intervention intervention (30.4%) were intervention intervention intervention intervention (30.4%) were intervention intervention intervention (30.4%) were intervention	There was considerable polypharmacy and data minimum below the polypharmacy among the residents and aminimum level of pharmacists' in: Strengths: Drew on skills of pharmacists from different sectors to address

					BMJ Open	bmjopen-2023- d by copyright,	
Twig 2015	5[24]	Service evaluation 620 patients (aged over 65 years and prescribed ≥ 4 medications)	Community pharmacies in England	Four or More Medicines (FOMM) support service. Patients were invited to participate in the service by the community pharmacy team. The pharmacist held regular consultations with the patient and discussed risk of falls, pain management, adherence and general health. They also reviewed the patient's medication using STOPP/START criteria. Data were analysed	Of 620 patients recruited, 441 (71.1%) completed the 6-month study period. Pharmacists made 142 recommendations to prescribers in 110 patients, largely centred on potentially inappropriate prescribing of NSAIDs, PPIs or duplication of therapy. At follow-up, there was a significant decrease in the total number of falls experienced and a significant increase in medicine adherence and quality of life. Cost per quality-adjusted life year estimates ranged from£11 885 to £32 466 depending on the assumptions made.	By focussing orders to text and data mining, Al training, and similar technologies. By focusing of life. By focusing orders to text and data mining, Al training, and similar technologies.	Strengths: Large sample of patients and providers; use o validated outcome measures Limitations: No control/comparator group; authors note some patients were probably reviewed independently by their GP during the study period; relatively high attrition rate

Appendix Table 2: TIDieR Lite for UK pharmacist studies

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Appendix Table	e 2: TIDieR Lite for UI	for the first 6 months of participation in the service. K pharmacist studies		by copyright, including for uses related to	.081934 on 7 August 2024. Do	
Intervention name and study ID(s)	By whom	What	Where	Intensity and da	wnloaded fr	How often
CHIPPS Alharthi 2023[18]; Birt 2021[21]; Lane 2020 [22]; Bond 2020[25]; Holland 2023[29]	Trained pharmacist independent prescribers (PIPs). The training programme comprised 2 days of face-to-face instruction, time in practice to develop relationships with the GP and care home staff, and to address any selfassessed competency gaps supported by a mentor, and a formal final sign-off by a GP independent of the research	PIP, in collaboration with the care home resident's GP, assumes responsibility for managing the medicines of the resident, including: • Reviewing resident's medication and developing and implementing a pharmaceutical care plan • Assuming prescribing responsibilities • Supporting systematic ordering, prescribing and administration processes with each care home, GP practice and supplying	Participating care homes	PIPs committed a minimum hours/month to delarge Each PIP provided care 20 residents	e service.	PIPs visited care homes weekly over 6 months

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		pharmacy where needed Providing training in care home and GP practice Communicating with GP practice, care home, supplying community pharmacy and study team		omjopen-2023-081934 on 7 August 2024. Downloa Enseignement Supe by copyright, including for uses related to text a	
Care home medication reviews Alves 2019[19]	Primary care pharmacists and GPs in Somerset CCG area and CCG staff	Medicines optimisation visits to care homes. Primary care pharmacists visited homes on behalf of GP practices; GPs could participate in visits or hold discussions with pharmacists prior to the visit; screening of safety interventions was done by CCG pharmacist leads	Care homes with and without nursing in Somerset	The time and level of a port allocated for the service was a regard with the respective CCG Locative harmacist Manager and influence by a number of factors such as engagement from GP practices; primary care pharmacists' availability; skills and confidence; number of care home patients registered with each GP practice; and geographic area covered by the prescribing support sharmacists	The aim of the programme was to offer at least one visit to as many care homes as possible (appears to be one visit per year but not explicitly stated)
Shine Medication Optimisation Project Baqir 2017[20]	Pharmacists together with care home nurses and other members of the multi-disciplinary team (MDT), including GPs and mental health professionals as needed. Two different models: pharmacists made prescribing decisions (as part of	A notes based, pharmacist-led review of medicines, where the Northumbria 3Q approach was applied to each medicine, that is, was there an indication, was the indication appropriate and was it safe?. Additionally, medicines missing that could be beneficial (eg, START medicines) were identified. This	Care homes in North East England	Intensity of interver	Once, as a funded quality improvement (QI) project

shared decision- was followed by a MDT meeting		<u> </u>	
shared decision- making) independently or in conjunction with GPs GPs GPs GPs GPs GPs GPs GPs	General Whe practices Midla deliv	D81934 on 7 August 2024. Downloaded from http://domnloaded from http	Data collected quarterly up to 12 months after starting the intervention[16]

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		sessions were to be held straight after running the searches and then at regular intervals. • Agree on an action plan, retained within the practice, for reviewing patients identified as high risk and improving prescribing and medication monitoring systems using root cause analysis Pharmacists (sometimes supported by pharmacy technicians) then work with, and support, general practice staff to implement the agreed action plan, sometimes making the necessary changes themselves	Prie	Enseignement Superieur (ABES) . ng for uses related to text and data mining, Al training, and similar	on 7 August 2024. Downloaded f	
(electronic medicines So optimisation system (EMOS))	actice managers and	Web-based user interface which securely extracts patient data from general practice patient records. Accessed separately from the GPs' clinical systems, it allows different stakeholders access to real time anonymized	General practices covered by the participating CCG		y) study) s 2025 at Agence Bibliographique de l	Not reported (qualitative study)

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Jeffries 2017[13]	patients) by a CCG in the South of England	patient data including medical histories of diagnoses, prescribed medications and test results. The EMOS is intended to facilitate clinical audits of prescribing activity to identify patients at risk of ADEs, or not appropriately monitored. Patients can access the system through a "Patient Passport"		-081934 on 7 August 2024. Downloa Enseignement Supe including for uses related to text a	
Safety Medication dASHboard (SMASH) Jeffries 2018[12]; Peek 2020[15]; Jeffries 2020[26]	Clinical pharmacists working in general practices and other general practice staff	Pharmacists were trained to deliver the intervention and apply root cause analysis techniques to identify, explore, resolve, and prevent medication errors in partnership with general practice staff. Pharmacists and practice staff were given access to a web-based, interactive dashboard that provided feedback on 12 indicators of potentially hazardous prescribing. The dashboard also provided practice-level summary data as well as educational material.	General practices covered by the participating CCG	Practices interacted with the dashboard a median of 12.0 (interaction artile range, 5.0–15.2) times per month towards regular but respectively and resolve new cases. The frequent of dashboard use was higher in practices with a larger number of at-risk parities.	Dashboard was updated daily. Frequency of use varied by practice and over time (see previous column)
Structured Medication Review (SMR)	Clinical pharmacists within general practice primary care networks (PCNs)	Invited, personalised, holistic review of all medicines and their benefits to health for people at risk of harm or medicine-related problems	General practices	Reviews are recommended to be scheduled for at least 30 minutes to allow time for shared decision-making in the commended of	Once

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Madden 2022[14]; Stewart 2021[27]				on 7 Aug E Ing for us	
Medicines optimisation intervention Syafhan 2021[17]	GP practice-based pharmacists operating as part of the wider primary care team	Each pharmacist received 2 days of intensive specialist training on medicines optimisation (including training on motivational interviewing). The intervention included: review of patient records prior to meeting; medication history; individual medicines optimisation plan that could include recommending/making changes to medication regimens (in collaboration with GPs), personalised education and counselling on medication management, the correct use of medication administration devices and lifestyle factors; and an agreed list of treatment goals. Pharmacists could also refer patients to another health professional within the practice. Having completed the intervention, the pharmacist	Eight general practices in four regions of the UK	Initial meeting with Superieur (ABES): In the Initial meeting with Supe	

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		produced a short report for the patient's GP outlining actions taken and any further recommendations requiring GP input		081934 on 7 Augus Enst including for uses	
Collaborative pharmacist review Thayer 2021[23]	Community and specialist mental health pharmacists	Medicine review using a structured framework based on recommendations of the 2018 Learning Disability Mortality Review (LeDeR) report. Pharmacists visited care homes to conduct the reviews using individual residents' care home records. The specialist mental health pharmacist also had access to the care record held by the Specialist Mental Health Trust, if the resident was under the Trust's care, and remote access to the local data sharing platform. Assessments included medicines adherence and burden (particularly the anticholinergic burden), respiratory care, vaccination status, constipation risk, sepsis prevention, dysphagia risk and lifestyle risk issues, especially smoking. Finally, pharmacists were asked to detail actions taken/advice provided, any	Care homes for people with intellectual disabilities	507 interventions for 160 residents review at and data mining, Al training, and similar technologies.	Once

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Four or More Medicines (FOMM) pharmacists and pharmacy team members the service arthur th	ecommendations made and make referrals, as necessary. ollowing the review, GP urgeries and psychiatrists were ontacted by the pharmacists of arrange a review of their ecommendations. As the charmacists were not prescribers, decisions on accepting recommendations were made by the resident's GP/psychiatrist (after reviewing the resident's full clinical ecord) in consultation with the charmacists were trained via distance learning and face to face, which included how to use the various different tools and assessments. Training was then cascaded to other charmacy members. The pharmacist held egular consultations with the charmacy are invited to participate in the service by the community pharmacy eam. The pharmacist held egular consultations with the patient and discussed risk of alls, pain management, dherence and general health. They also reviewed the	Participating community pharmacies	bmjopen-2023-081934 on 7 August 2024. Downloaded from http://bog/ation.d 11 Enseignement Superieur (ABES). Enseignement Superieur (ABES). Enseignement Superieur (ABES). Pharmacist time else com/ on June 9, 2025 at Agence Bibliographique de le restration of the minutes for monthlygand similar technologies. Pharmacist for quarter for quarter for quarter for quarter for minutes for quarter	After the first consultation, patients met with the pharmacist on a regular basis depending on when they collected their repeat medication or they felt a need.

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Excluded on country

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Excluded on date

1. Hanlon JT, Weinberger M, Samsa GP, Schmader KE, Uttech KM, Lewis IK, Cowper PA, Landsman PB, Cohen HJ, Feussner JR: A randomized, controlled trial of a clinical pharmacist intervention to improve inappropriate prescribing in elderly outpatients with polypharmacy. American journal of medicine 1996, 100(4):428-437.

SEARCH STRATEGIES in full (for Appendix / supplementary material)

Ovid MEDLINE(R) ALL <1946 to February 06, 2023>

- 1 Inappropriate Prescribing/ 4485
- 2 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or nonessential or inessential) adj3 prescri*).mp. 8188
- 3 (overprescri* or over-prescri*).mp. 1975
- 4 Polypharmacy/ or (polypharmacy or poly-pharmacy).ti,ab. 12777
- 5 1 or 2 or 3 or 4 21236

- 6 exp Primary Health Care/ or (primary health care or primary healthcare or primary care).mp. 289526
- 7 general practice/ or family practice/ 78114
- 8 (GP or general practi* or family practice or family physician* or community pharmac* or dental or dentist* or optometr* or optician*).mp. 751694
- 9 6 or 7 or 8 997387
- 10 (deprescri* or de-prescri*).mp. 2577
- 11 (structured medication review or medication reconciliation or medicine* optimi#ation or shared decision making or personalised care).mp. 16563
- 12 ((intervention* or initiative* or campaign*) adj3 (pharmacist* or pharmacy technician*)).mp. 3182
- 13 10 or 11 or 12 21842
- 14 5 and 9 and 13 540
- *Medication Errors/ and 9 and 13 232
- 16 5 and 9 and pc.fs. 835
- 17 14 or 15 or 16 1416
- 18 limit 17 to yr="2013 -Current" 1152
- remove duplicates from 18 1145

Embase <1974 to 2023 Week 05>

- 1 Potentially inappropriate medication/ 2458
- 2 unnecessary prescribing/ [+NT] 51
- 3 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or nonessential or inessential) adj3 prescri*).mp. 11262
- 4 (overprescri* or over-prescri*).mp. 3064
- 5 Polypharmacy/ or inappropriate polypharmacy/ or (polypharmacy or poly-pharmacy).ti,ab. 26382
- 6 1 or 2 or 3 or 4 or 5 39236
- 7 exp Primary Health Care/ or primary medical care/ or (primary health care or primary healthcare or primary care).mp. 281889
- 8 general practice/ or family practice/ 83634
- 9 (GP or general practi* or family practice or family physician* or community pharmac* or dental or dentist* or optometr* or optician*).mp. 766031
- 10 7 or 8 or 9 974647
- 11 (deprescri* or de-prescri*).mp. 3587
- 12 (structured medication review or medication reconciliation or medicine* optimi#ation or shared decision making or personalised care).mp. 28235
- 13 ((intervention* or initiative* or campaign*) adj3 (pharmacist* or pharmacy technician*)).mp. 6755
- 14 11 or 12 or 13 37710
- 15 6 and 10 and 14 813
- 16 6 and 10 and pc.fs. 308
- 17 15 or 16 1089
- 18 limit 17 to yr="2013 -Current" 903
- 19 remove duplicates from 18 886

APA PsycInfo <1806 to January Week 5 2023>

- 1 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or nonessential or inessential) adj3 prescri*).mp. 788
- 2 (overprescri* or over-prescri*).mp. 329
- 3 (polypharmacy or poly-pharmacy).mp. 3128
- 4 1 or 2 or 3 4078
- 5 (primary health care or primary healthcare or primary care).mp. 44486
- 6 (GP or general practi* or family practice or family physician* or community pharmac* or dental or dentist* or optometr* or optician*).mp. 34287
- 7 5 or 6 71196

- 8 (deprescri* or de-prescri*).mp. 336
- 9 (structured medication review or medication reconciliation or medicine* optimi#ation or shared decision making or personalised care).mp. 3969
- 10 ((intervention* or initiative* or campaign*) adj3 (pharmacist* or pharmacy technician*)).mp. 242
- 11 8 or 9 or 10 4505
- 12 4 and 7 and 11 44

45 46 S8

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or optician*)

(MH "Family Practice")

"Polypharmacy+")

S1 OR S2 OR S3 OR S4 OR S5

polypharmacy or poly-pharmacy

overprescri* or "over prescri*"

(MH "Inappropriate Prescribing")

(MH "Polypharmacy (Saba CCC)") OR (MH

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11)	Search	HIIS

- #1 MeSH descriptor: [Inappropriate Prescribing] explode all trees 234
- #2 MeSH descriptor: [Polypharmacy] explode all trees 312
- #3 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or "non

essential" or inessential) near/3 prescri*):ti,ab,kw 771

- #4 (overprescri* or "over-prescri*"):ti,ab,kw 161
- #5 (polypharmacy or poly-pharmacy):ti,ab,kw 1288
- #6 #1 or #2 or #3 or #4 or #5 2045
- #7 MeSH descriptor: [Primary Health Care] explode all trees 9989
- #8 MeSH descriptor: [General Practice] explode all trees 2877
- #9 MeSH descriptor: [Family Practice] explode all trees 2242
- #10 ("primary health care" or "primary healthcare" or "primary care"):ti,ab,kw 24053
- #11 (GP or "general practi*" or "family practice" or "family physician*" or "community pharmac*" or dental or dentist* or optometr* or optician*):ti,ab,kw 44879
- #12 #7 or #8 or #9 or #10 or #11 70362
- #13 MeSH descriptor: [Deprescriptions] explode all trees 68
- #14 (deprescri* or de-prescri*):ti,ab,kw 364
- #15 ("structured medication review" or "medication reconciliation" or "medicine* optimi*" or "shared decision making" or "personalised care" or "personalized care"):ti,ab,kw2425
- #16 ((intervention* or initiative* or campaign*) near/3 (pharmacist* or pharmacy)):ti,ab,kw 1559
- #17 #13 or #14 or #15 or #16 4166
- #18 #6 and #12 and #17 130

(3 reviews, 127 trials)

MMAT quality assessment results

Reference	Screening questions	Type of study	MMAT questions and answers 🖁 🖫 💆
Alharthi	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach approach approach to answer the research
2023[18]	questions? Yes		question? Yes (identifying perceive riers and facilitators)
			1.2. Are the qualitative data colle இத்திற்று the adequate to address the
			research question? Can't tell (secon analysis of existing data)
	S2. Do the collected data allow		1.3. Are the findings adequately dense from the data? Yes
	to address the research		1.4. Is the interpretation of result ട്രായ്ക്ക് മ്ലൂiciently substantiated by data? Yes
	questions? Yes		1.5. Is there coherence between വ്യൂഷ്ട്രീയ്ക്ക് tive data sources, collection,
		MO -	analysis and interpretation? Yes () rted by use of Theoretical Domains
			Framework)
Alves	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes (care
2019[19]	questions? Yes	randomised	home residents)
			3.2. Are measurements appropriate regarding both the outcome and
			intervention (or exposure)? Yes
	S2. Do the collected data allow		3.3. Are there complete outcome data Can't tell (partial data presented)
	to address the research		3.4. Are the confounders accounted for in the design and analysis? No
	questions? Yes		(uncontrolled before/after study) $\frac{\Omega}{\omega}$
			3.5. During the study period, is the intervention administered (or exposure
			occurred) as intended? Can't tell (Adelity not monitored)
Baqir	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes (care
2017[20]	questions? Yes	randomised	home residents) 9
			3.2. Are measurements appropriate regarding both the outcome and
			intervention (or exposure)? Yes \overline{g} ω
	S2. Do the collected data allow		3.3. Are there complete outcome data Yes (all specified outcomes
	to address the research		reported)
	questions? Yes		3.4. Are the confounders accounted for in the design and analysis? No
			(uncontrolled before/after study)
			3.5. During the study period, is the intervention administered (or exposure
			occurred) as intended? Can't tell (interwentions not externally validated)

		ВМЛ	omjopen-2023 by copyright
Birt 2021[21]	S1. Are there clear research questions? Yes	Mixed methods	5.1. Is there an adequate rational forgusing a mixed methods design to address the research question? Yes (qualitative and quantitative data relevant to process evaluation)
	S2. Do the collected data allow to address the research questions? Yes		5.2. Are the different components of the study effectively integrated to answer the research question? Yes and discussion) 5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpret sets (see discussion) 5.4. Are divergences and inconsistences between quantitative and qualitative results adequately addressed? Yes (page 11 column 2) 5.5. Do the different components at the study adhere to the quality criteria of each tradition of the matter size involved? Yes
Howard 2014[11]	S1. Are there clear research questions? Yes S2. Do the collected data allow to address the research questions? Yes	Quantitative descriptive	4.1. Is the sampling strategy relevant to address the research question? Yes 4.2. Is the sample representative of the target population? Yes (all interventions recorded) 4.3. Are the measurements appropriate? Yes 4.4. Is the risk of nonresponse bias low? Yes (data from intervention arm only) 4.5. Is the statistical analysis appropriate to answer the research question? Yes
Jeffries 2017[13]	S1. Are there clear research questions? Yes S2. Do the collected data allow to address the research questions? Yes	Qualitative	1.1. Is the qualitative approach appropriate to answer the research question? Yes (explored factors perceived to affect adoption and implementation) 1.2. Are the qualitative data collection methods adequate to address the research question? Yes (interviews and focus groups) 1.3. Are the findings adequately derived from the data? Yes (context-mechanism-outcome groups identified) 1.4. Is the interpretation of results sufficiently substantiated by data? Yes 1.5. Is there coherence between qualificative data sources, collection, analysis and interpretation? Yes (supported by use of realist analysis)
Jeffries 2018[12]	S1. Are there clear research questions? Yes	Qualitative	1.1. Is the qualitative approach appropriate to answer the research question? Yes (explored factors perceived to affect adoption and implementation)

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	S2. Do the collected data allow to address the research questions? Yes		1.2. Are the qualitative data collection methods adequate to address the research question? Yes (interviews) 1.3. Are the findings adequately derived from the data? Yes 1.4. Is the interpretation of results sufficiently substantiated by data? Yes (supported by relevant quotes) 1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation? Yes (supported by use of Normalisation Proces)
Lane 2020[22]	S1. Are there clear research questions? Yes S2. Do the collected data allow to address the research questions? Yes	Qualitative	1.1. Is the qualitative approach appropriate to answer the research question? Yes (gather opinions about proposed service) 1.2. Are the qualitative data colleging methods adequate to address the research question? Yes (focus groups and interviews with different staff groups at different sites) 1.3. Are the findings adequately denoted from the data? Yes 1.4. Is the interpretation of results sufficiently substantiated by data? Yes (supported by relevant quotes) 1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation? Yes (supported by use of Theoretical Domains)
Madden 2022[14]	S1. Are there clear research questions? Yes S2. Do the collected data allow to address the research questions? Yes	Qualitative	1.1. Is the qualitative approach appropriate to answer the research question? Yes (pharmacists' experience of SMR implementation) 1.2. Are the qualitative data collection methods adequate to address the research question? Yes (interviews with newly employed and established pharmacists) 1.3. Are the findings adequately derived from the data? Yes 1.4. Is the interpretation of results sufficiently substantiated by data? Yes (supported by relevant quotes) 1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation? Yes (supported by thematic analysis)
Peek 2020[15]	S1. Are there clear research questions? Yes	Quantitative non- randomised	3.1. Are the participants representative of the target population? Yes (general practices and their patients) 3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)? Can't tell For intervention)

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	S2. Do the collected data allow		3.3. Are there complete outcome gata ? Yes
	to address the research		3.4. Are the confounders accounted for in the design and analysis? No
	questions? Yes		(small risk of unmeasured confounding)
	queenens, / es		3.5. During the study period, is the intervention administered (or exposur
			occurred) as intended? Can't tell (இதிentions not externally validated)
Rodgers	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes
2022[16]	questions? Yes	randomised	(general practices and their patien 景景 2
			3.2. Are measurements appropria \hat{E}_{a} \hat{E}_{a} arding both the outcome and
			intervention (or exposure)? Can't & f or intervention)
	S2. Do the collected data allow		3.3. Are there complete outcome 👸 👸 ව No (6- and 12-month data not
	to address the research	6	collected from all practices)
	questions? Yes		3.4. Are the confounders account இடிற்ற in the design and analysis? No
			(small risk of unmeasured confound and small risk of unmeasured confound and unmeasured confou
		NA	3.5. During the study period, is the intervention administered (or exposur
			occurred) as intended? Can't tell (Eterventions not externally validated)
Syafhan	S1. Are there clear research	Quantitative	2.1. Is randomisation appropriately performed? Can't tell (method of
2021[17]	questions? Yes	randomised controlled	randomisation not reported)
		trial	2.2. Are the groups comparable agbaseline? Yes
			2.3. Are there complete outcome ata No (30% lost to follow-up or
	S2. Do the collected data allow		withdrew)
	to address the research		2.4. Are outcome assessors blinded to the intervention provided? Can't
	questions? Yes		tell (outcome data from GP electronic records)
			2.5 Did the participants adhere to the assigned intervention? No (30% lost
	S4 A	0	to follow-up or withdrew)
Thayer	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes (care
2021[23]	questions? Yes	randomised	home residents with intellectual digabilities)
			3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)? Yes (details recorded for each review and
	S2. Do the collected data allow		associated outcomes)
	to address the research		3.3. Are there complete outcome data? Yes (all specified outcomes
	questions? Yes		reported)
	questions: 763		3.4. Are the confounders accounted for in the design and analysis? No
			(uncontrolled before/after study)
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			3.5. During the study period, is the intervention administered (or exposure
			occurred) as intended? Yes (one-o # review mainly based on records)
Twigg	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Can't tell
2015[24]	questions? Yes	randomised	(no indication of attempts to recruit a presentative sample)
			3.2. Are measurements appropriate and intervention (or exposure)? Yes (date) recorded for intervention
	S2. Do the collected data allow		components and associated outco像毒尽
	to address the research		3.3. Are there complete outcome विक्रुं हिंदि Can't tell (limited response for
	questions? Yes		resource use outcomes)
			3.4. Are the confounders account ക്ലൂട്ട് in the design and analysis? No
		6	(uncontrolled before/after study) and read a
		\mathcal{O}_{\triangle}	3.5. During the study period, is the ត្រីដើម្បីrvention administered (or exposure
			occurred) as intended? Can't tell (ब्रिक्ट्रेड्रिय) x. 30% withdrawal rate)
	For peer		ig, Al training, and similar technologies. gpen.bmj.com/on June 9, 2025 at Agence Bibliographique de l inpen.bmj.com/site/about/guidelines.xhtml



PRISMA 2020 Checklist

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PRISM	MA 20	BMJ Open Cted by Copyrigh Cted by Copyrigh Cted by Copyrigh	
Section and Topic	Item #	Checklist item	Location where item is reported
TITLE	l	, , , , , , , , , , , , , , , , , , ,	repertou
Title	1	Identify the report as a systematic review.	Title
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p2
INTRODUCTION		9.00	
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction (pp4-5)
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Methods (p6)
METHODS		* 	
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Methods (p6)
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted the date when each source was last searched or consulted.	Methods (p7)
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used	Supplementary file
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation to be seen the process.	Methods (p7)
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each to whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, detage of automation tools used in the process.	Methods (pp7-8)
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which set to collect.	Methods (pp7-8)
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, stinding sources). Describe any assumptions made about any missing or unclear information.	Methods (pp7-8)
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how might reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Methods (p8)
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	See methods (p8)
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	See methods (p8)
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	N/A (summary tables only)
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used 2	N/A
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analyas, meta-regression).	Methods (p8)
	13f	Describe any sensitivity amanyses conducted to-dasses/nobjustness of the syrithesized tresuits lines.xhtml	N/A



PRISMA 2020 Checklist

Castion and	It our	'ght, i	Location
Section and Topic	Item #	Checklist item	where iter reported
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting (aisses)).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Results (p
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to t	P10 and Figure 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Suppleme table
Study characteristics	17	Cite each included study and present its characteristics.	Tables 1-
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Suppleme table
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) and the stimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Tables 1- where available appropria
Results of	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Results (p
syntheses	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the treatment of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Results (
DISCUSSION		2025 0025	
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Discussion (especiall p27)
	23b	Discuss any limitations of the evidence included in the review.	Discussion (especial p26)
	23c	Discuss any limitations of the review processes used.	Discussion (pp27-28
	23d	Discuss implications of the results for practice, policy, and future research.	Discussion (pp28-29
OTHER INFORMA	TION		
Registration and	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Title page



Pag	je 89 of 88			cted b	136/bn	
1 2	PRISI	MA 20	220 Charliffer	by copyrigh	36/bmiopen-2023	
3 4 5	Section and Topic	Item #	Checklist item	t. includ	3- 08193	Location where item is reported
6	protocol	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	ina	on The state of th	Title page
/ 8		24c	Describe and explain any amendments to information provided at registration or in the protocol.	for	7	P9
9	Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in	Žine (eview.	Title page
10 11	Competing interests	26	Declare any competing interests of review authors.	seign s rela	list 20	Title page
12 13 14	Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection form studies; data used for all analyses; analytic code; any other materials used in the review.	ement S	ta extracted from included	Data sharing statement (p30)
15 16 17	From: Page MJ, McKe	nzie JE, I	Checklist item Indicate where the review protocol can be accessed, or state that a protocol was not prepared. Describe and explain any amendments to information provided at registration or in the protocol. Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in Declare any competing interests of review authors. Report which of the following are publicly available and where they can be found: template data collection form studies; data used for all analyses; analytic code; any other materials used in the review. Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting system. For more information, visit: http://www.prisma-statement.org/	uper⊯ur xt an⊌ da	operation of the state of the s	10.1136/bmj.n71
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BMJ Open

Pharmacist-led primary care interventions to promote medicines optimisation and reduce overprescribing: a systematic review of UK studies and initiatives

Journal:	BMJ Open
Manuscript ID	bmjopen-2023-081934.R1
Article Type:	Original research
Date Submitted by the Author:	18-Apr-2024
Complete List of Authors:	Chambers, Duncan; The University of Sheffield, ScHARR; Preston, Louise; University of Sheffield, ScHARR Clowes, Mark; University of Sheffield, ScHARR Cantrell, Anna; University of Sheffield, ScHARR Goyder, Elizabeth; ScHARR, University of Sheffield
Primary Subject Heading :	General practice / Family practice
Secondary Subject Heading:	Pharmacology and therapeutics
Keywords:	Primary Care < Primary Health Care, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Patient-Centered Care, Systematic Review

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Pharmacist-led primary care interventions to promote medicines optimisation and reduce overprescribing: a systematic review of UK studies and initiatives

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Conflict of interest: The authors have no conflicts of interest to declare

Total word count: Main text including tables 8040

Keywords: Overprescribing, deprescribing, medicines optimisation, primary care, pharmacist, United Kingdom, scoping, systematic

Funding and registration: NIHR Health Services & Delivery Research
Programme (project number NIHR135767). PROSPERO registration number
CRD42023396366. The full protocol is available online at
https://fundingawards.nihr.ac.uk/award/NIHR135767

Abstract

Objectives: To systematically review and synthesise evidence on the effectiveness and implementation barriers/facilitators of pharmacist-led interventions to promote medicines optimisation and reduce overprescribing in UK primary care.

Design: Systematic review

Setting: UK primary care

Methods: We searched MEDLINE, Embase, CINAHL PsycINFO and The Cochrane Library for UK-based studies published between January 2013 and February 2023. Targeted searches for grey literature were conducted in May 2023. Quantitative and qualitative studies (including conference abstracts and grey literature) that addressed a relevant intervention and reported a primary outcome related to changes in prescribing were eligible for inclusion. Quality of included studies was assessed using the Multiple Methods Appraisal Tool (MMAT). We performed a narrative synthesis, grouping studies by publication status, setting and type of data reported (effectiveness or implementation).

Results: We included 14 peer reviewed journal articles and 11 conference abstracts, together with four case study reports. The journal articles reported 10 different interventions, five delivered in general practice, four in care homes and one in community pharmacy. The quality of evidence was higher in general practice than in care home settings. It was consistently reported that the intervention improved outcomes related to prescribing, although the limited number of studies and wide range of outcomes reported made it difficult to estimate the size of any effect.

Implementation was strongly influenced by relationships between pharmacists and other health and care professionals, especially GPs. Implementation in care homes appeared to be more complex than in general practice because of differences in systems and 'culture' between health and social care

Conclusions: Pharmacist-led interventions have been reported to reduce overprescribing in primary care settings in the UK but a shortage of high-quality evidence means that more rigorous studies using high-quality designs are needed. More research is also needed in community pharmacy settings; to assess intervention effects on patient outcomes other than prescribing; and to investigate how reducing overprescribing can impact on health inequalities.

Registration: PROSPERO [CRD42023396366].

Strengths and limitations of this study

We included evidence often excluded from systematic reviews to get as full a picture as
possible of how pharmacist-led interventions are implemented and sustained in practice as
well as their characteristics and effectiveness.

• Some review processes were performed by a single reviewer and meta-analysis was not feasible.



Introduction

This evidence review was performed to support implementation of the National Overprescribing Review for England (NOR; see below)) by examining research on pharmacist-led overprescribing interventions in UK primary care settings. Pharmacists are trained to provide advice and support to patients and other health professionals, pharmacist independent prescribers (PIPs) have existed since 2006 and patients are increasingly asked to consider the community pharmacy as a first source of support for minor health conditions. Alongside community pharmacies, many general practices have pharmacists as members of the practice team. Pharmacists, working with GPs and other healthcare professionals, are thus well placed to support interventions directed towards medicines optimisation and the reduction of overprescribing. Such interventions include carrying out structured medication reviews directly with patients and carers and/or reviewing data from patient records. The aims and objectives of the review are outlined below, following a brief clarification of terminology.

Overprescribing has been defined as 'the use of a medicine where there is a better non-medicine alternative, or the use is inappropriate for that patients' circumstances and wishes'[1]. Overprescribing is often related to the concept of problematic polypharmacy, where harmful effects result from the prescription of multiple medications. However, there is no agreed definition of polypharmacy and patients with complex health conditions may require multiple medications.

Medicines optimisation is an umbrella term for interventions designed to ensure that medicines are used safely and effectively, producing the best possible outcomes for patients. In this context, deprescribing refers to the process of stopping medications that are no longer appropriate to a patient's needs. Deprescribing is a response to overprescribing and problematic polypharmacy and involves collaboration between health professionals and patients and/or carers to ensure shared decision-making. Shared decision-making with patients and/or carers is fundamental to successful medicines optimisation[2] but the need for time and resources to ensure that this takes place can create barriers to service delivery. Another related term, medicines reconciliation, is a more technical process to ensure consistency between prescription records and the medications the patient is actually receiving and taking. The terminology around overprescribing and other forms of medicines misuse was recently reviewed by Singier et al[3]. Medication review involves examining a patient's prescriptions as a whole and is separate from measures to reduce inappropriate prescribing of specific medications or types of medication such as antibiotics or proton pump inhibitors.

Overprescribing can cause direct harm to patients in a variety of ways. It has been estimated that about 6.5% of hospital admissions are caused by harmful effects of medication, rising to 20% for people aged over 65[1]. In addition to physiological harms, long-term use of some medications can lead to dependency and problems when attempting to withdraw the medication.

Issues relating to prescribed medication can arise from a whole range of causes, including patients requiring treatment for multiple conditions, lack of co-ordination between different health professionals or organisations and failures of communication between health professionals and patients (for example failing to gather information because of time constraints on appointments). Availability of new medications and increasing numbers of people living with long-term conditions such as arthritis and diabetes have resulted in patients being prescribed more medications and continuing to take them for long periods of time, often for life. The average number of prescription

Pharmacists are thus well placed to support processes of medicines optimisation, which involve them working closely with medical professionals (particularly GPs), commissioners of health care and patients. The report of the National Overprescribing Review for England, published in 2021, provides numerous examples and case studies[1].

The National Overprescribing Review (NOR) for England was set up in 2018 to evaluate the extent of overprescribing in the NHS and recommend measures to reduce it, particularly in primary care. A review of existing research (overview of systematic reviews) was commissioned to support the national review[4]. The NOR identified a need for a more consistent and effective approach to medication review, which requires both the identification of effective interventions and an understanding of the factors that need to be addressed in terms of organisational and cultural barriers to implementation. The national review's recommendations included changes to systems (patient records, transfers of care and clinical guidance) and culture (reduced dependence on medication and support for shared decision-making), as well as the appointment of a National Clinical Director for Prescribing[1].

This evidence review was commissioned to support implementation of the NOR recommendations by examining research on pharmacist-led overprescribing interventions in UK primary care settings. We aimed to assess the effects of relevant interventions on outcomes related to prescribing, identify key characteristics of the interventions and examine barriers and facilitators to implementation in routine practice. A further aim was to assess the quality of the evidence base and identify priorities for further research. In addition to this UK-focused paper, outputs from the project include a broader scoping review of reviews of interventions for overprescribing in primary care (Preston et al. in preparation) and an evidence-based analysis of factors for service commissioners and providers to consider in developing and delivering services to reduce overprescribing and optimise medication use.

Methods

i.

Review aims and objectives

We aimed to perform a systematic review of published literature and published or informally published evaluations reporting UK-based, pharmacist-led interventions for overprescribing, including the following components:

- A review and synthesis of outcomes of effective interventions
- ii. A review of the characteristics of effective interventions using the TIDieR framework
- iii. Evaluation of the UK evidence base in terms of quality and risk of bias
- iv. Identification of case study examples of effectively implemented interventions in the UK

Inclusion and exclusion criteria

Inclusion criteria for the review were as follows

- Population/setting: UK primary care
- Intervention: Pharmacist-led interventions aimed at review and optimisation of prescribed medications
- Comparator: Not required
- Outcomes: Studies had to report a primary outcome related to changes in prescribing.
 Secondary outcomes were other patient and health service outcomes, including but not limited to changes to type of medicines prescribed, quality of life, hospital admissions and deaths.
- Study design: Quantitative and qualitative studies were eligible for inclusion, with no
 exclusions based on study design or quality. Reports of local initiatives published as grey
 literature reports or conference abstracts were included to give a fuller picture of activity
 across the NHS.
- Other: Studies published in English between January 2013 and February 2023

We excluded interventions aimed at reducing overprescribing of specific medications or types of medication, e.g. antibiotics or proton pump inhibitors. Studies of children and young people were also excluded.

Search methods

A common literature search was performed for this review and the associated scoping review of reviews (Preston et al. in preparation). Searches were conducted by an information specialist (MC) in order to identify published and unpublished evidence on primary care interventions to reduce overprescribing.

Phase 1: peer reviewed literature

A first phase of database searches was run in February 2023 to retrieve relevant peer-reviewed literature. Searches were designed around the following concepts:

PROBLEM	INTERVENTION	SETTING
Overprescribing; Inappropriate prescribing; polypharmacy	Deprescribing; Structured medication review; medication reconciliation; medicines optimisation; shared decision making; personalised care	Primary Care (including international terms for primary care where relevant)

While we are aware of the Morel filter (2022) for identifying studies of deprescribing[5], our focus was specifically on a primary care setting. Search strategies are provided in supplementary file 1.

Searches covered the databases MEDLINE, Embase, CINAHL, PsycINFO and The Cochrane Library and were limited to studies published since 2013 and in OECD countries with healthcare systems similar to the UK.

Phase 2: grey literature

A further phase of targeted searches was conducted in May 2023 to identify unpublished or "grey" literature. This involved searching for the case studies identified by the National Overprescribing Review (to identify any which had produced a report or evaluation), and then searching the Overton.io platform for pharmacist-led deprescribing/overprescribing and medicines optimisation.

Searches were complemented by input from stakeholders (internal and external topic advisers) to minimise the risk of missing any other relevant evidence.

Study selection

Records retrieved by the literature search were stored in a shared EndNote library and deduplicated. Screening for inclusion at the title level was performed by single reviewers after piloting of a test set. Reviewers could refer records to another team member in the event of uncertainty and a 20% sample of records was screened by a second reviewer to validate title level inclusion decisions.

Screening for inclusion at the abstract and full text level was performed by pairs of reviewers acting independently. Disagreements were resolved by discussion among the reviewers involved (AC, DC and LP). A good level of agreement was achieved, values of kappa between pairs of reviewers ranging from 0.67 to 0.96. Reasons for exclusion at the full text stage were recorded.

Data extraction

Data extraction tables and summary tables were developed in Microsoft Word. Extraction was performed by a single reviewer, with a 10% sample being checked for consistency and accuracy. In addition to standard data extraction fields (study design/sample size, setting, intervention, key findings and strengths/limitations), we used the TIDieR Lite framework to collect information on the features of interventions reported as 'successful' to determine whether service commissioners and providers should consider specific factors when commissioning/delivering services. TIDieR Lite is a simplified version of the TIDieR (Template for Intervention Description and Replication) checklist [6].

Quality assessment

Methodological quality of peer reviewed journal articles was assessed using the Mixed Methods Appraisal Tool (MMAT) version 2018[7]. The tool includes screening questions and methodological quality questions for different study designs (qualitative, randomised trials, non-randomised quantitative studies, descriptive studies and mixed methods). Quality assessment results were combined with identified strengths and limitations (including those reported by study authors) to characterise the contribution of individual studies and groups of studies to the overall evidence base.

Data synthesis

We performed a narrative synthesis of the included studies using text and tables to describe study and intervention characteristics in line with methodological and reporting guidelines[8, 9]. We initially grouped studies by publication status, considering peer-reviewed journal articles (regardless of study design and quality) separately from conference abstracts and case studies. Within these three categories, we grouped studies by setting (general practice, care homes or community settings). We also distinguished between studies reporting effectiveness of interventions and those reporting implementation of interventions (e.g. qualitative studies and process evaluations). In view of study heterogeneity and reporting limitations, effectively implemented interventions were defined as those where the study authors' conclusions indicated that the service was regarded as a success and was planned to continue or be expanded.

Studies reported a wide variety of outcomes using diverse effect measures. For this reason we did not attempt to calculate a standardised metric to compare effect sizes across outcomes. The synthesis used a 'vote-counting' method (number and proportion of studies reporting positive, negative or neutral outcomes), prioritising prescribing-related outcomes over patient and other outcomes. Reported effect measures and associated 95% CIs were recorded in the text and tables. Tables of study characteristics and findings were presented alphabetically by author for consistency. While reporting results from all study designs we prioritised stronger study designs (experimental and quasi-experimental) over those of uncontrolled observational studies. In terms of exploring heterogeneity, the structure of the synthesis allowed consideration of potential modifiers including study design, study quality and setting. Intervention components and aspects of implementation were examined using modifications of existing frameworks, the component analysis was prespecified in the review protocol.

Public involvement

The review was supported by a public panel who provided feedback on public perceptions that informed the review and are reflected in the Discussion.

Variations from protocol

We used Tidier Lite instead of the full TIDieR framework. This was because the full framework is designed to allow the replication of interventions and therefore goes beyond the degree of detail required for evidence synthesis.

Results

Results of literature search

The PRISMA flow diagram (Figure 1) summarises the study selection process. After screening 1774 records at the title and abstract stage and 215 full-text articles, we included 14 published articles, 11 conference abstracts and four case study reports. The majority of exclusions were of studies conducted outside the UK, with a smaller number excluded because the intervention was not pharmacist—led or the article did not report empirical data. Characteristics of the included studies are reported in the following sections.

Please insert Figure 1: PRISMA flow diagram near here

Research studies

Study characteristics

Study characteristics are summarised in Table 1, with full data extraction tables in supplementary file 2. The 14 publications reported on ten interventions, of which five were delivered in general practice (seven publications[11-17]), three in care homes for older people (five publications[18-22]), one in care homes for people with intellectual disabilities (ID) [23] and one in community pharmacies[24].

All the interventions involved medication review in some form. Distinctive features of interventions included use of IT to identify patients for review[11-13, 15, 16]; a key role for pharmacist independent prescribers in medication management in care homes[21, 22]; and employment of pharmacists by groups of general practices (primary care networks, PCNs) to provide a holistic patient-centred service specified by NHS England[14]. Intervention characteristics are considered in more detail below.

Study designs used included one individual RCT[17] and two cluster RCTs (CHIPPS[18, 21] and PINCER[11]), although the primary publications of the latter two trials fell outside the time period covered by this review. Two studies used an interrupted time series (ITS) design[15, 16] and five used qualitative approaches[12-14, 18, 22]. One study was a mixed methods process evaluation[21]. The remaining studies were described as service evaluations or quality improvement reports with an uncontrolled before vs. after design [19, 20, 23, 24].

Included studies reported a wide range of outcomes (Table 1). For further analysis, see below under 'effects of interventions' and 'Implementation/system issues, respectively. None of the studies reported details of participants other than age and sex, making it difficult to assess equity, diversity and inclusion across the evidence base.

Table 1: Summary of research study characteristics

		BMJ Open		bmjopen-2023-081934 on 7
able 1: Sumi	mary of research study charad	cteristics		934 on 7
Reference	Population	Intervention	Study design	Ogtrome measures
Quantitative	controlled studies			es)
Howard 2014[11]	Pharmacists delivering intervention	IT-enabled pharmacist-led review to reduce medication errors	Cluster RCT (PINCER trial)	T讀賣數ken to complete reviews; r霞朝知nended interventions and whether the 程安ere implemented
Peek 2020[15]	General practice patients with one or more risk factors for hazardous prescribing or inadequate blood test monitoring	Pharmacist-led Safety Medication dASHboard (SMASH) intervention	Interrupted time series analysis	R person potentially hazardous person and inadequate blood-test medical from a second potentially hazardous person and inadequate blood-test medical from a second potentially hazardous person and second pot
Rodgers 2022[16]	General practices in the East Midlands	Pharmacist-led IT intervention (PINCER)	Multiple interrupted time series	Inglescors of potentially hazardous prescribing
Syafhan 2021[17]	Patients in participating GP practices at risk of MRPs	Pharmacist-supplemented care focusing on medication optimisation	Individual RCT	Nmmber of medication related problems (NmRPs) and medication inappropriateness places of medication inappropriateness
Quantitative	uncontrolled studies		C 1.	<u>a</u> <u>3</u> .
Alves 2019[19]	Care home residents	Medication review by primary care pharmacists linked to GP practices	Service evaluation (5 year uncontrolled study)	Ingerventions by pharmacist (including deprescribing and changes to person)
Baqir 2017[20]	Care home residents	Medication review by pharmacist with or without GP	Retrospective analysis of data from QI programme	Namber and type of medications stopped
Thayer 2021[23]	Care home residents with intellectual disabilities	Collaborative service initiative involving community pharmacists and a specialist mental health pharmacist providing review of medicines and lifestyle risk factors	Service evaluation	interventions/recommendations and acceptance by GPs and psychiatrists
		For peer review only - http://bmjopen.bmj.con	n/site/about/guidelines.xh	Bibliographique de

- ·		To		mjopen-2023-081
Twigg	Patients over 65	Community pharmacist consultation	Service evaluation	Number of recommendations; falls,
2015[24]	prescribed four or more medications	including medication review using STOPP/START rules		nईdication adherence, quality of life and costs होt 6 months
Oualitative	/mixed methods	STOPP/START Tules		
Alharthi	Care home residents	Deprescribing by pharmacist	Qualitative	Bक्रुम्बर्द्धेs and facilitators to deprescribing
2023[18]			interviews with	i i i i i i i i i i i i i i i i i i i
		·	participants in a	2024.
			cluster RCT (CHIPPS	d me
			study)	ont ov
Birt	Care home residents	Pharmacist independent prescribers	Mixed methods	Pr 5 3 vities, perceived benefits and
2021;[21]		responsible for medicines management (CHIPPS)	process evaluation	b के हैं कि s to implementation
Jeffries	Pharmacists delivering	Pharmacist-led intervention involving	Qualitative	The s related to implementation of the
2018[12]	intervention, GPs and CCG	the use of an electronic audit and	interviews	ing ntion and role of practice
	staff	feedback surveillance dashboard to		parmacists and others
		Pharmacist independent prescribers Pharmacist independent prescribers responsible for medicines management (CHIPPS) Pharmacist-led intervention involving the use of an electronic audit and feedback surveillance dashboard to identify patients potentially at risk of hazardous prescribing or monitoring of medicines in general practice		A Din
			•	omjoper
				<u> </u>
Jeffries	Stakeholders in general	Electronic medicines optimisation	Qualitative realist	Significant Support implementation of
2017[13]	practice and CCG	system	evaluation	the system
Lane	Doctors, pharmacists,	Pharmacist independent prescriber	Qualitative focus	Perceived benefits of the service and
2020[22]	care-home managers and	service	groups and	baries and facilitators to implementation
	staff, residents and relatives		interviews	June
Madden	Pharmacists working in	Structured medication review (SMR)	Qualitative interview	Tigemes related to early implementation of
2022[14]	general practice within	service within Primary Care Networks	study	Teemes related to early implementation of See R service
	PCNs	,	,	<u>e</u> 21

Table 2: Summary of studies reporting effects of interventions

Tablo 2: Sum	mary of studies reporti	ng offacts of intorvon	BMJ Open	bmjopen-2023-081934 on
Reference	Intervention	Setting	Study design and sample size	Outcome measure and effect size
Alves 2019[19]	Medication review	Care homes	Service evaluation 10,405 patient reviews over 5 years	Interventions by pharmacised to to te.
Baqir 2017[20]	Medication review	Care homes	Retrospective evaluation of quality improvement project 422 residents in 20 care homes	Number and type of medical by stopped 19.5% reduction in number of medicines being prescribed relative to baseline (ABET).
Peek 2020[15]	Safety medication dashboard	General practice	Interrupted time series 43 general practices covering 235,595 people in Salford, Greater Manchester	Potentially hazardous prescribing (composite of 10 indicators) Potentially hazardous prescribing reduced by 27.9% (95% CI 20.3% to 36.8%, $p < 0.001$) at 24 vectors and by 40.7% (95% CI 29.1% to 54.2%, $p < 0.001$) at 12 months
Rodgers 2022[16]	Pharmacist-led IT- assisted intervention (PINCER)	General practice	Multiple interrupted time series 393 general practices covering approximately 3 million patients	Indicators of potentially hat bus prescribing The PINCER intervention was a sociated with a decrease in the rate of hazardous prescribing of 6.2% (adjusted odds ratio (aOR) 0.83, 95% confidence interval (C\$0.80 to 0.86) at 6 months and 15.3% (aOR 0.85, 95% CI 0.80 to 0.80) at 12 months post-intervention
Syafhan 2021[17]	Pharmacist-led medicines optimisation	General practice	Individual RCT 356 patients at risk of medication-related	Medication-related problems (PRP); Medicines Appropriateness Index (MAI) Median number of MRPs per intervention patient at 6 months was reduced from 3 to 0.5 ($p < 0.00$) in patients who received the full

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			problems (MRPs) from 8 GP practices	intervention schedule. MAR cogs were reduced (medications more appropriate) for the intervention group, but not for control group.
Thayer 2021[23]	Review of medicines and lifestyle risk factors	Care homes for adults with intellectual disabilities (ID)	Service evaluation 160 care home residents with ID	Pharmacist interventions/recommendations and acceptance by GPs and psychiatrists
Twigg 2015[24]	Community pharmacist consultation including medication review	Community pharmacies	Service evaluation 620 patients (aged over 65 years and prescribed	Number of recommendation adherence, quality of life and costs at 6 month symplectic and data mining (ABES).
			≥ 4 medications	ing, Al training, and similar technologies.
				nologies.

Intervention characteristics

Table 2 in supplementary file 2 summarises characteristics of the included interventions using the TIDieR Lite checklist. The table includes limited data extracted from studies cited by included studies but not themselves included in the review [25-27].

The pharmacists involved in delivering the interventions were variously described as pharmacist independent prescribers[21]; trained pharmacists and pharmacy technicians[11, 16]; primary care pharmacists[19]; clinical pharmacists working in general practice[13-15]; GP practice-based pharmacists working as part of a wider primary care team[17]; community and specialist mental health pharmacists[23]; and community pharmacists and pharmacy team members[24]. One study simply referred to 'pharmacists'[13].

Four interventions were explicitly stated to require training of pharmacists to deliver them[11, 17, 21, 24]; the extent of training was described for three of these[17, 21, 24]. Training pharmacists to deliver the PINCER intervention was described in a separate paper[11]. Interventions were delivered with other primary care team members depending on the setting of the study and in some cases with staff employed by clinical commissioning groups (CCGs). In particular, only the CHIPPS study involved pharmacists with the power to prescribe medication independently; in other studies recommendations were passed to the patient's GP or another medically qualified professional for implementation. Shared decision-making with patients and/or families was specifically reported for three interventions[14, 17, 20].

Reporting of interventions varied between studies. Most studies reported the process of medication review including patient selection for review and the review itself in more detail than resulting follow-up actions. Two qualitative studies reported limited details of the review process[12, 14], although a service specification was available for the NHS England structured medication review (SMR) investigated by Madden et al.[14]. For studies where the intervention was primarily directed at improving medication review processes using general practice data[11-13], it was unclear whether there was a standard process to discuss findings with the patient and make changes to their prescriptions. All studies reporting on effectiveness of medication reviews stated that the person undertaking the review had access to relevant patient records[15-17, 19, 20, 23, 24].

Intensity of interventions was also variably reported. In the CHIPPS study, PIPs committed a minimum of 16 hours/month to deliver care to approximately 20 care home residents[25]. Madden et al. reported that SMR appointments were recommended to allow at least 30 minutes for review and shared decision-making[14]. The medicines optimisation intervention evaluated by Syafhan et al. involved up to three meetings between patient and pharmacist[17], while the FOMM study in community pharmacies estimated times of 25 minutes for initial consultation, 10 minutes for monthly review and 11 minutes for quarterly review[24]. Other studies reported that time and level of support allocated to interventions varied between and within CCG areas depending on local resources and priorities[16, 19]. Another measure of intervention intensity was the number of recommended actions, averaging 3.3/resident in care home residents with intellectual disabilities[23].

Most included studies reported on a single round of medication reviews with variable periods of follow-up. As noted above, some interventions required multiple interactions between pharmacists and patients.

Effects of interventions

 Seven studies reported on effects of pharmacist-led interventions in some form (Table 2): three in general practice[15-17], three in care homes[19, 20, 23] (including one in a care home for people with ID[23]) and one in community pharmacies[24].

The strongest evidence for the effectiveness of interventionscame from the studies in general practice. The interrupted time series (ITS) studies of Peek et al.[15] and Rodgers et al.[16], which used indicators of inappropriate prescribing to identify patients for intervention, reported significant decreases in inappropriate prescribing at 6 and 12 months after intervention (Table 2). Estimated reductions were larger in Peek et al. (27.9% and 40.7%) compared with Rodgers et al. (16.7% and 15.3%)[15, 16]. The 95% confidence intervals of the two studies at 12 months did not overlap, suggesting some uncertainty about the magnitude of the effect. The randomised trial by Syafhan et al.[17] preferentially recruited patients based on prescription of six or more medications and a history of recent unplanned hospital admission. The intervention was associated with a reduction in medication-related problems in those who completed the full programme (up to three appointments) and an improvement in MAI scores.

Of the three studies set in care homes, only Baqir et al. reported a direct effect on prescribing associated with medication review, a 19.5% reduction in number of prescribed medicines[20]. Alves et al.[28] reported on pharmacist interventions and potential financial savings over 5 years. In the one year reported in detail, 24.5% of interventions involved deprescribing. Potential drug cost savings were estimated at £812,441 annually, of which £431, 493 (55%) was attributed to deprescribing. The study of Thayer et al.[23] differed from the others in involving care home residents with intellectual disabilities. There was a high level of polypharmacy at baseline and pharmacists made an average of 3.3 interventions/recommendations per resident, of which 12.8% involved deprescribing. A large majority of pharmacist recommendations were accepted by GPs/psychiatrists caring for the residents.

The one study in a community pharmacy setting recruited patients aged 65 or older who were prescribed four or more medications[24]. Of 620 patients recruited, 441 (71.1%) completed the 6-month study. Pharmacists made 142 recommendations related to 110 patients, largely dealing with potentially inappropriate prescribing of NSAIDs and PPIs or duplication of therapy. The study also reported a significant decrease in falls and improvements in medication adherence and quality of life at follow-up.

The review included two publications from the CHIPPS Care Homes Independent Pharmacist Prescriber Study) trial[18, 21] but the paper reporting effectiveness and safety results from this cluster RCT[29] was published too late for formal consideration for inclusion in our review. The primary outcome was rate of falls, with Drug Burden Index (DBI) being one of the secondary outcomes. Fall rate at 6 months did not differ significantly between intervention and control groups

but DBI was lower in the intervention group (mean 0.66 vs. 0.73; adjusted rate ratio 0.83, 95% CI 0.74 to 0.92).

Implementation/system issues

Seven studies provided quantitative and/or qualitative evidence on factors affecting implementation of pharmacist-led interventions, of which four were performed in general practice[11-14] and three in care homes[18, 21, 22].

The general practice studies focused on different parts of the implementation pathway. Two dealt with implementation of IT systems to support detection of potentially hazardous prescribing[12, 13]; one was a process evaluation of the PINCER trial[11]; and one focused on implementation of structured medication reviews as recommended by NHS England in routine practice[14]. The studies of IT-supported interventions were broadly positive about the potential for implementation and sustainability, but the study of NHS England's SMR programme concluded that its early implementation failed to deliver the planned holistic and patient-centred approach.

Other evidence

Conference abstracts

We included 11 conference abstracts (Table 4), of which two were earlier reports of studies subsequently published as full papers[28, 30]. All of the included abstracts focused on intervention effects on prescribing and related outcomes.

Five abstracts reported research in general practice, of which three involved patients with polypharmacy identified from the overall practice population[31-33]. As a group, these three abstracts provided weak evidence of associations between pharmacist-led medication reviews and changes in medication and cost savings together with high levels of patient satisfaction (Table 3),

Two abstracts reported on selected general practice populations. The only comparative study in this group reported that patients living with frailty who were reviewed by a pharmacist as part of a multi-disciplinary team review had a reduction in total medications compared with a control cohort[34]. When patients recently discharged from hospital were reviewed by a pharmacist working in their general practice, 16 out of 35 had changes made to their medication, with 74% of changes involving deprescribing[35].

Turning to studies performed in care homes, two abstracts by Doherty et al. (2020)[36, 37] evaluated an intervention entitled Medicines Optimisation in Older People (MOOP) which involved case management by pharmacists. The authors reported that inappropriate prescribing (based on the MAI) was highly prevalent at baseline *84%) but declined significantly following the intervention. Swift et al. reported that a team comprising pharmacists and pharmacy technicians who both performed medication reviews and supported care home staff significantly reduced inappropriate polypharmacy (measured by prescribing quality indicators) between 2024 and 2017[38]. For care home residents receiving palliative care, structured medication reviews involving shared decision-

Grey literature case studies

We included reports of four case studies reporting on local initiatives in three areas of England (see Table 4). Details of all case studies may be found in Annex C of the National Overprescribing Review report[1]. Case studies were submitted by NHS organisations (mainly CCGs) and included varying amounts of data on intervention characteristics, support for implementation and outcome measures. Three interventions were delivered in general practice and one in care homes. The initiative developed by Swale CCG was distinctive in using pharmacy technicians to review less complex cases, although the initiative was targeted at patients considered high-risk for ADRs. Although not classified as research, such case studies can provide useful data on implementation of interventions and outcomes achieved in routine practice



Table 3: Summary of studies published as conference abstracts

			BMJ Open	bmjopen-2023-081934
Table 3: Summa	ry of studies published a	as conference abstracts		bmjopen-2023-081934 on 7
Reference	Population	Intervention	Study design	Outcome measuges and key findings
Alves 2016[28]	Care home residents	Medication review by primary care pharmacists linked to GP practices	Service evaluation (retrospective analysis and interviews)	Interventions by harmonist; barriers and facilitators A total of 2916 in the represented 22% of which depressed as a partial series and facilitators at 1047 patients, of which depressed as a partial series and facilitators
Bryant 2019[31]	Primary care patients taking ten or more medications	Polypharmacy clinics in GP surgeries	Service evaluation (retrospective data analysis)	Reductions in property ing; cost savings; hospital admissions avoiding a partial admission avoiding a part
Chauhan 2022[35]	Patients recently discharged from hospital	Post-discharge medication review by clinical pharmacist linked to GP practice	Formative service evaluation (uncontrolled)	Medication change following review 16/35 patients had medications changed; 74% (25/34) of changes were medications stopped
Din 2020[32]	Patients referred by GPs	Polypharmacy review clinics led by pharmacist independent prescriber with shared decision-making	Service evaluation (uncontrolled)	Changes to medication, feedback from patients and MDT Pharmacist medication reviews were effective, with positive feedback received from patients and members of the MDT. Deprescribing and inhaler counselling were the most common interventions.
Din 2022[34]	Primary care patients living with frailty	Frailty review involving pharmacist as part of MDT	Comparative cohort	Changes in mediation (including cholinergic burden), practice contact and falls Intervention group had a reduction in total number of medications when compared with non-intervention cohort. Anti-cholinergic burden scores were reduced by a mean of 26%
		For peer review only - http://br	njopen.bmj.com/site/abo	ibliographique de

			BMJ Open	bmjopen-2023-
Doherty 2020a[36], 2020b[37]	Care home residents	Medicines Optimisation in Older People (MOOP) involving case management by pharmacists	Uncontrolled before/after	Inappropriate prescribing; unplanned hospital admissions; GP visits; clinical interventions Inappropriate prescribing was highly prevalent at baseline (84.1%) but improve ≱ significantly from baseline (M = 14.87, SD = 13.1
Donyai 2017[33]	Patients aged at least 75 years and prescribed 15 or more medication	Pharmacist-led polypharmacy review clinic in primary care	Survey	Patient satisfaction and the service helpful, 13% did not know and 2% did not respond
Kolovetsios 2018[39]	Care home residents needing palliative care	Structured medication reviews carried out in agreement with patient, nurse, family/carer and GP	Service evaluation	Changes to medication, estimated cost savings From January 2017 of January 2018, 574 medication reviews took place substituting in 1787 suggested medication changes. Approximately 76% of these changes were agreed and ctioned by patients' GPs, with estimated saving of 169,986.96.
Swift 2018[38]	Care home residents	Care home team (pharmacists and pharmacy technicians) delivering medication reviews and supporting care home staff	Service evaluation	Prescribing quality ingicators (including reduced inappropriate polypharmacy); CQC ratings Medication reviews were completed for 749 care home residents between August 2014 and March 2017. Of the recommendations made to prescribers, 85% were accepted and resulted in a reduction in inappropriate polypharmacy
Syafhan 2019[30]	Patients in participating GP practices at risk of MRPs	Pharmacist-supplemented care focusing on medication optimisation	Individual RCT	Number of medication related problems (MRPs) and medication inappropression of 356 addition in the medication inappropression of 356 addition

Table 4: Summary of selected grey literature case studies

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Table 4: Summar	ry of selected grey literature	case studies	mjopen-2023-081934 on 7 by copyright, including fo
Setting	Name of initiative	Key findings	Comments
Brighton and	An evaluation of a clinical	A total of 1,300 patients were referred into the service	The target fatient cohort of frail or older
Hove CCG	pharmacist medication	and reviewed between April 2017 and March 2018; 9%	person received polypharmacy was identified
	review service in primary	of patients were deprescribed high-risk medicines	from sea swithin GP clinical systems and
	care		through grade from clinical practitioners,
			volunta സ്റ്റ് ശ്ലൂട്ട് d social care services
Swale CCG	Medicines Optimisation	In 2018/19, pharmacists and pharmacy technicians	Target ្ន <mark>ី គ្គី ថ្ល</mark> high-risk' patients
	Review Programme	reviewed 5281 patients and made 3859 interventions,	Key fear use of technicians for less complex
		37% for adverse drug reactions (ADRs). Estimated in-	cases data (fro
		year cost savings were £239,546	n m m
NE Hampshire	Care homes pharmacist	Pharmacist accompanying GPs visiting care homes	Limited reported
and Farnham		carried out over 250 medication reviews and 800	9, /b
CCG		interventions. Average number of medicines per	mjop VI tra
		resident fell from 9.4 to 7.6	
NE Hampshire	Polypharmacy	Tool developed by Wessex AHSN was used to identify	Limited at are reported
and Farnham	prescribing comparators	patients at risk of harm, resulting in significant	, and
CCG		reductions in percentage of patients aged over 75	G SO
		prescribed 15 or more medications and percentage with	simila
		an anticholinergic burden score of 6 or more	
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Study quality

Quality assessment results using the MMAT are presented in supplementary file 3. The results should be read in conjunction with the study strengths and limitations (see Table 1 in supplementary file 1).

Five different checklists within the MMAT were used to assess the 14 studies. The sample included one RCT[17]; six studies were classified as quantitative non-randomised[15, 16, 19, 20, 23, 24]; one as quantitative descriptive[11]; one as mixed methods[21]; and five as qualitative[12-14, 18, 22]. All studies passed the screening questions (are there clear research questions? and do the collected data allow to address the research questions?)

The RCT by Syafhan et al. was described as a pragmatic trial and was at relatively high risk of bias for this type of design. The trial did not achieve the planned number of participants and there was a high rate of attrition (about 30%), meaning that many participants did not receive the full intervention or provide outcome data. The trial also suffered from unclear reporting: method of randomisation and whether outcome assessors were blinded was not reported, making it difficult to assess overall risk of bias.

The quantitative non-randomised studies comprised four observational studies at high risk of bias because of the absence of a control group[19, 20, 23, 24] and two large ITS studies[15, 16]. The MMAT tool identified some limitations of these studies, including some risk of confounding and incomplete outcome data in one study[16]. However, these were large studies conducted in routine practice and providing evidence of a statistically significant effect at 12 months post-intervention. The process evaluations of the CHIPPS[21] and PINCER[11] studies both scored highly on the MMAT assessment.

The qualitative studies were generally of good quality, with sufficient data presented in support of conclusions and appropriate use of frameworks and thematic analysis to organise presentation of the findings. The study by Alharthi et al.[18] was a secondary analysis of data collected for another purpose, making it unclear whether qualitative data collection methods were adequate.

Using the system applied by the authors in previous studies of complex health service interventions[10], the overall strength of evidence was classified as borderline 'stronger' (generally consistent findings in multiple studies with a comparator group) for general practice, 'weaker' (generally consistent findings in one study with a comparator group design and several non-comparator studies or multiple non-comparator studies) for care homes and 'very limited' (single study) for community pharmacies.

Effectively implemented interventions

Three research studies met the criteria for 'effectively implemented' interventions: the closely related PINCER[16] and SMASH[15] interventions in general practice and the Somerset model of medication review in care homes[19]. Further examples of effectively implemented medication review in care homes were identified among the included conference abstracts[36-39]. Case studies from Brighton and Hove and Swale CCGs appeared to report effectively implemented interventions

targeted at high-risk patients in general practice (Table 5). An evaluation of the early implementation of SMRs in primary care networks indicated that the service as provided did not match the vision of a patient-centred holistic review with an emphasis on shared decision-making[14].

.Discussion

Summary of findings

In spite of its broad inclusion criteria, this review identified a relatively small number of studies of pharmacist-led interventions in UK primary care (14 peer reviewed journal articles, 11 conference abstracts and four case studies). Overall, the bulk of evidence came from the care home sector but most of the better quality evidence was derived from studies conducted in general practice. The majority (8/14) of peer reviewed papers were published in 2020 or later, suggesting that this is a developing area of research and practice in the context of encouraging patients to consult pharmacists initially for minor conditions and to increase pharmacists' prescribing rights. It was encouraging that we identified a number of effectively implemented interventions and initiatives in both care homes and general practice.

Outcomes of effective interventions

This systematic review suggests that pharmacist-led interventions may reduce overprescribing in primary care settings in the UK, although more controlled studies are needed. The evidence is strongest for interventions implemented in general practice, where we identified a small randomised trial[17] as well as two large quasi-experimental studies (interrupted time series)[15, 16] and various uncontrolled studies and service evaluations. Evidence from care home settings was of lower quality with the exception of the CHIPPS study involving pharmacist independent prescribers working in care homes[21]. We located only one uncontrolled study based in UK community pharmacies[24].

Although the direction of reported effects was clear, the limited number of controlled studies combined with the wide range of outcomes reported makes it difficult to estimate the size of any effect. For example, the two ITS studies using similar interventions reported markedly different reductions in measures of inappropriate prescribing at 6 and 12 months after implementation of the intervention[15, 16]. Uncertainty about effect sizes is increased because many of the studies lacked a control group and the results could have been influenced by other interventions in the health and social care system, for example the Enhanced Health in Care Homes programme implemented in England. While our review focused primarily on outcomes related to prescribing, data on cost savings were also widely reported but the evidence was generally of low quality. We also found limited evidence of a link between reductions in measures of overprescribing and clinical outcomes, mainly because of lack of reporting. The CHIPPS study found no significant difference in its primary outcome of fall rate, although there was a reduction in Drug Burden Index (a secondary outcome) in the intervention group at 6 months[29].

Characteristics of effective interventions

The TIDieR Lite checklist provided a suitable structure for describing intervention characteristics for evidence synthesis purposes and this discussion follows its structure. Lack of reporting (especially of

intervention intensity/frequency) was a limiting factor, as was reporting of varying intervention information across multiple publications.

Medication reviews were undertaken by pharmacists acting independently or in conjunction with GPs or care home staff. In a study in care homes for people with intellectual disabilities, psychiatrists were also involved in review where appropriate[23]. Pharmacy technicians were also involved in the PINCER study and could potentially have a greater role in relatively straightforward medication reviews[11, 16]. The included studies reported a variety of models of employment of pharmacists, including direct employment by GP practices, CCG Medicines Optimisation Teams, PIPs and community pharmacists. PCNs support employment of pharmacists by general practices and are the route chosen by NHS England to implement its model of SMR.

A major difference between settings is the need to identify patients requiring medication review in general practice, whereas most care home residents take multiple medications and could be considered candidates for review as part of their routine health care. A key element of the PINCER[11, 16] and SMASH[15] interventions is the use of information technology to search electronic patient records efficiently across large numbers of general practices. Effective interventions were also characterised by attention to training and tools to support and sustain change in practice, e.g. an 'audit and feedback' dashboard[15].

Training of pharmacists and other staff to deliver interventions was reported to varying degrees, reflecting in part the publication channel of the research. For example, in the CHIPPS study PIPS had comprised 2 days of face-to-face instruction plus time in practice to develop relationships with the GP and care home staff. [21] Specification and provision of appropriate training will be important for future development of pharmacist-led interventions, as also highlighted by the evaluation of NHS England's SMR programme [14].

Intervention intensity is another important factor in developing and delivering interventions. For the CHIPPS study, participating PIPs committed a minimum of 16 hours/month to the service. [21] In general practice settings, NHS England recommended allowing 30 minutes for an SMR to give time for shared decision-making; this was interpreted to include time for preparation and writing-up[14]. This level of time requirement was also reported in the one study from a community setting, which estimated pharmacist time at 25 minutes for an initial consultation[24].

In terms of intensity more generally, resourcing of interventions was reported to vary between commissioning groups (CCGs) depending on staff availability and other priorities[11, 16, 19]. General practices varied in their use of a medication safety dashboard[26]. Frequency of intervention was rarely reported, reflecting the short time frame of most included studies but it seems possible that there could be an ongoing need for review as patients get older and/or their health state changes.

Quality and risk of bias

The MMAT provided a good alternative to the use of multiple tools to assess risk of bias across diverse study designs. The only randomised trial assessed was designed as a pragmatic trial[17] and the assessment confirmed a relatively high risk of bias. Publications from the CHIPPS study were included but the trial *per se* was not assessed for risk of bias because of the publication date of the main study report. Similarly, the PINCER intervention was supported by a randomised trial published in 2012, before the cut-off date for our review [40]). Well-conducted studies included in the review included large ITS studies[15, 16], process evaluations[11, 12, 21] and qualitative studies[13, 14].

Implementation barriers and facilitators

Implementation of pharmacist-led interventions was strongly influenced by factors affecting relationships between pharmacists and other health and care professionals, especially GPs. Given that most pharmacists are not prescribers, their recommendations around (de)prescribing need to be seen as 'legitimate' by GPs who are generally responsible for acting on the recommendations. This is facilitated by continuity at the system level, including existing links between pharmacists and GPs[21] and good access to data[12]. Jeffries et al. reported that pharmacists took the lead in developing relationships with GPs, enabling a 'learning health system'[12]. The benefits of continuity at the system level could help to explain why early implementation of the SMR programme through the relatively new medium of PCNs was reported to be less successful than initially hoped[14].

Implementation in care homes may be more complex than in general practice because of differences in systems and 'culture' between health and social care[22]. Patients and their families may be supportive of medication review or oppose it based on real or perceived benefits of medication[18].

The main message regarding implementation of pharmacist-led interventions across all settings is the need for involvement of all relevant stakeholders, preferably before starting the process of implementation, to understand the context and anticipate possible barriers[22].

Identification of effectively implemented interventions/initiatives:

Our simple criteria for 'effectively implemented' interventions/initiatives identified a number of examples published as research papers, conference abstracts or case studies (see 'Effectively implemented interventions' above). Despite limitations as research, some of the abstracts and case studies provided valuable information about how commissioners and providers had supported interventions and their commitment to continue the programme[36-39]. In other studies, despite promising results, it was unclear whether the intervention would be implemented more widely[17].

Relationship to previous research

To our knowledge, this is the first systematic review of pharmacist-led interventions and initiatives specifically in UK settings. A scoping review of reviews by the same authors (Preston et al., in preparation) included 20 systematic reviews published between 2014 and 2023. The most recent review covered pharmacist integration into general practice to optimise prescribing and outcomes for patients with polypharmacy[41]. The review included 23 studies, of which just three were from the UK. The conclusion that pharmacist integration probably reduced PIP and number of medicines (moderate certainty evidence) was in line with the findings of the present review. A 2016 systematic review by Riordan et al. focused on pharmacist-led interventions to optimise prescribing in older community-dwelling adults in primary care[42]. The authors concluded that pharmacist-led interventions may improve appropriateness of prescribing but the quality of evidence was low. The

review included randomised and quasi-randomised studies published before December 2015, giving it limited overlap with our review.

Strengths and limitations

The UK focus is both a strength and limitation of this review. We included evidence often excluded from systematic reviews to get as full a picture as possible of how pharmacist-led interventions are implemented and sustained in practice as well as their characteristics and effectiveness. The dual focus reflects the fact that pharmacist-led medicines optimisation and deprescribing in primary care is both an area of active research and of implementation within the health care system. Nevertheless, some of the evidence is not of high quality and we have tried to be appropriately cautious in our conclusions and identified implications.

Our broad review questions and UK focus resulted in a heterogeneous group of included studies. Meta-analysis was not possible so we performed a narrative synthesis in line with appropriate guidelines[8, 9]. The review was undertaken by a small but experienced team with expertise in systematic review methods and prescribing.

Implications for service delivery

Several studies indicate that barriers to successful service delivery often arise from 'system' issues and differences in 'culture' [14, 22]. Commissioners and providers engaged in developing new pharmacist-led services should ensure equitable access to data and information to avoid perceptions of 'ownership' by certain groups at the expense of others [13]. In care homes, where medication review is an important component of health care for residents [19], implementation requires health and social care professionals to work together and 'understand each other's systems' [22]. The holistic patient-centred SMR envisaged by NHS England may require culture change/training to foster an emphasis on direct patient contact and shared decision-making. Removal of financial incentives for PCNs to carry out SMRs as reported recently (https://pharmaceutical-journal.com/article/news/nhs-england-removes-financial-incentives-for-structured-medication-reviews-in-2023-2024) may complicate delivery, although the service remains a contractual requirement.

Services have been delivered successfully through CCGs Medicines Optimisation Teams with suitable training[11, 16]. The review also found evidence that services provided by PIPs appear to be a valid alternative to approaches requiring action by GPs or other medical professionals[21].

Implications for research

A major priority for research is to further evaluate the effectiveness of medication review in community pharmacy settings and how pharmacies might be best supported to deliver the service. A related need is for research to better understand public perceptions of community pharmacies as a

setting for medication review and their pros and cons compared with alternative settings such as GP surgeries. Research is needed to support the development of the PIP role and how PIPs might best be used in combination with GPs and other professionals to support optimal prescribing across the health and care system.

Shared decision-making is key to the success of pharmacist-led interventions. Research is needed to better understand patient and family attitudes to shared decision-making in the context of deprescribing and the barriers and facilitators operating in different settings and with different professionals.

The present review focused on outcomes related to prescribing and a review of effects on patient and health system outcomes would be a logical follow-up. Finally, further research is needed to understand the effects of implementing pharmacist-led medication review in general practice on health inequalities and how to reduce unwarranted variations in service delivery between different practices or regions.

Conclusions

The evidence base for pharmacist-led interventions varies widely in terms of quality but studies have consistently reported improvements relative to a comparator group or baseline. The diversity of interventions and outcomes reported makes it difficult to generalise about effect sizes but given the reported extent of the problem, even small relative reductions could be beneficial for patients and the health and care system.

The existing evidence base requires cautious interpretation because of a shortage of controlled studies and this is particularly the case for studies in community pharmacy settings. Further rigorous evaluation of interventions, particularly those delivered in community pharmacies, is required. Although not a focus of this review, there appears to be a shortage of high-quality economic evidence to guide decision-making by service commissioners and providers.

The problems encountered in the early implementation of NHS England's SMR programme[14] suggest a need for further research on the implementation of pharmacist-led interventions. Implementation of this type of interventions requires the involvement of all relevant stakeholders, preferably before starting the process of implementation, to understand the context and anticipate possible barriers.

Funding

This work was supported by the National Institute for Health and Care Research (award ID NIHR 135767). The funder had no role in drafting the paper or approving the version to be submitted

Conflict of interest

The authors have no conflicts of interest to declare.

Disclaimer

This report presents independent research funded by the National Institute for Health and Care Research (NIHR). The views and opinions expressed are those of the authors and do not necessarily reflect those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health and Social Care.

Contribution of authors

Duncan Chambers contributed to all review processes and wrote the first draft of the paper. Louise Preston managed the review team, and contributed to all review processes and to writing the paper. Mark Clowes developed search strategies, performed literature searches and contributed to writing the paper. Anna Cantrell contributed to all review processes and to writing the paper. Elizabeth Goyder provided topic expertise and contributed to writing the paper. All authors have approved the version to be submitted.

Data sharing

Any additional data not included in this report and its appendices are available on request. All queries should be submitted to the corresponding author.

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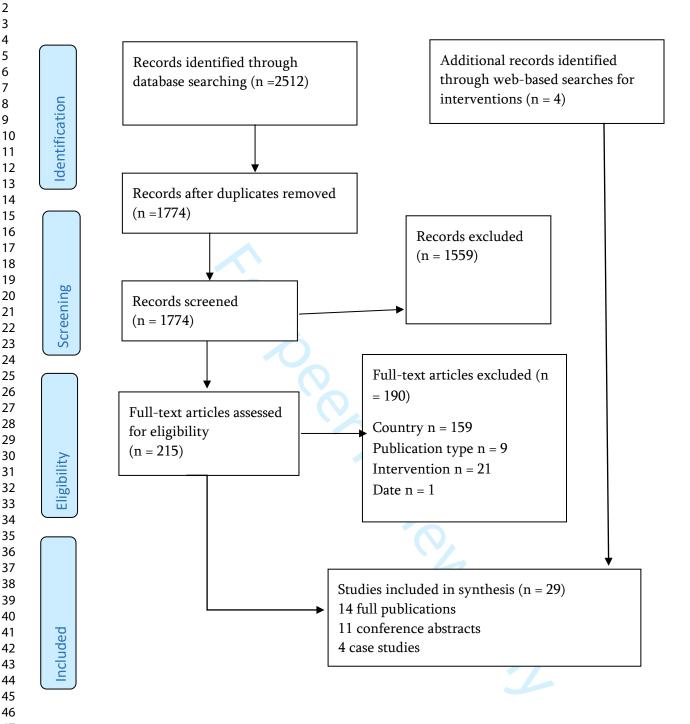
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SEARCH STRATEGIES in full (for Appendix / supplementary material)

Ovid MEDLINE(R) ALL <1946 to February 06, 2023>

- 1 Inappropriate Prescribing/ 4485
- 2 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or nonessential or inessential) adj3 prescri*).mp. 8188
 - (overprescri* or over-prescri*).mp. 1975
- 4 Polypharmacy/ or (polypharmacy or poly-pharmacy).ti,ab. 12777
- 5 1 or 2 or 3 or 4 21236
- 6 exp Primary Health Care/ or (primary health care or primary healthcare or primary care).mp. 289526
- 7 general practice/ or family practice/ 78114
- 8 (GP or general practi* or family practice or family physician* or community pharmac* or dental or dentist* or optometr* or optician*).mp. 751694
- 9 6 or 7 or 8 997387
- 10 (deprescri* or de-prescri*).mp. 2577
- 11 (structured medication review or medication reconciliation or medicine* optimi#ation or shared decision making or personalised care).mp. 16563
- 12 ((intervention* or initiative* or campaign*) adj3 (pharmacist* or pharmacy technician*)).mp. 3182
- 13 10 or 11 or 12 21842
- 14 5 and 9 and 13 540
- *Medication Errors/ and 9 and 13 232
- 16 5 and 9 and pc.fs. 835
- 17 14 or 15 or 16 1416
- 18 limit 17 to yr="2013 -Current" 1152
- remove duplicates from 18 1145

Embase <1974 to 2023 Week 05>

- 1 Potentially inappropriate medication/ 2458
- 2 unnecessary prescribing/ [+NT] 51
- 3 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or nonessential or inessential) adj3 prescri*).mp. 11262
- 4 (overprescri* or over-prescri*).mp. 3064
- Polypharmacy/ or inappropriate polypharmacy/ or (polypharmacy or poly-pharmacy).ti,ab. 26382
- 6 1 or 2 or 3 or 4 or 5 39236
- 7 exp Primary Health Care/ or primary medical care/ or (primary health care or primary healthcare or primary care).mp. 281889
- 8 general practice/ or family practice/ 83634
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- 10 7 or 8 or 9 974647
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- 12 (structured medication review or medication reconciliation or medicine* optimi#ation or shared decision making or personalised care).mp. 28235
- 13 ((intervention* or initiative* or campaign*) adj3 (pharmacist* or pharmacy technician*)).mp. 6755
- 14 11 or 12 or 13 37710
- 15 6 and 10 and 14 813
- 16 6 and 10 and pc.fs. 308
- 17 15 or 16 1089
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APA PsycInfo <1806 to January Week 5 2023>

- 1 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or nonessential or inessential) adj3 prescri*).mp. 788
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- 4 1 or 2 or 3 4078
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- 6 (GP or general practi* or family practice or family physician* or community pharmac* or dental or dentist* or optometr* or optician*).mp. 34287
- 7 5 or 6 71196
- 8 (deprescri* or de-prescri*).mp. 336
- 9 (structured medication review or medication reconciliation or medicine* optimi#ation or shared decision making or personalised care).mp. 3969

- 10 ((intervention* or initiative* or campaign*) adj3 (pharmacist* or pharmacy technician*)).mp. 242
- 11 8 or 9 or 10 4505
- 12 4 and 7 and 11 44

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- #1 MeSH descriptor: [Inappropriate Prescribing] explode all trees 234
- #2 MeSH descriptor: [Polypharmacy] explode all trees 312
- #3 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or "non essential" or inessential) near/3 prescri*):ti,ab,kw 771
- #4 (overprescri* or "over-prescri*"):ti,ab,kw 161
- #5 (polypharmacy or poly-pharmacy):ti,ab,kw 1288
- #6 #1 or #2 or #3 or #4 or #5 2045
- #7 MeSH descriptor: [Primary Health Care] explode all trees 9989
- #8 MeSH descriptor: [General Practice] explode all trees 2877
- #9 MeSH descriptor: [Family Practice] explode all trees 2242
- #10 ("primary health care" or "primary healthcare" or "primary care"):ti,ab,kw 24053
- #11 (GP or "general practi*" or "family practice" or "family physician*" or "community pharmac*" or dental or dentist* or optometr* or optician*):ti,ab,kw 44879
- #12 #7 or #8 or #9 or #10 or #11 70362
- #13 MeSH descriptor: [Deprescriptions] explode all trees 68
- #14 (deprescri* or de-prescri*):ti,ab,kw 364
- #15 ("structured medication review" or "medication reconciliation" or "medicine* optimi*" or "shared decision making" or "personalised care" or "personalized care"):ti,ab,kw2425
- #16 ((intervention* or initiative* or campaign*) near/3 (pharmacist* or pharmacy)):ti,ab,kw 1559
- #17 #13 or #14 or #15 or #16 4166
- #18 #6 and #12 and #17 130

(3 reviews, 127 trials)

Table 1: Study characteristics of included research studies (full data extraction table)

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Data extra	action tables				mjopen-2023-081934 on 7 August 2024. Enseignem by copyright, including for uses related	
Table 1: St	udy characteristi Study design/sample	Setting	Intervention	s (full data extraction table) Key findings	gust 2024. Downloa Enseignement Supe ses related to text a	Study strengths/limitations
Alharthi 2023[18]	size Secondary analysis of qualitative interview data 11 pharmacist independent prescribers (PIPs) who participated in a cluster randomised trial	Care homes in England and Scotland	Integration of PIPs into care homes to improve medication management	Factors that acted as both enablers and barriers were PIP relationship with General Practitioner (GP), care home staff and residents/families, awareness of the PIP role and family trust in PIPs' deprescribing activities (social influences); PIPs' independent prescribing confidence, previous experience and ability dealing with residents' medications (beliefs about capabilities); understanding of PIP role and PIP confidence in their role as an independent prescriber (social/professional role and identity); access to residents' records, deprescribing decision support, regular follow-up from care home staff, resident difficulties with medications,	PiPs' involvemed by the period care homes is influenced by the period of the period care homes is influenced by the period of th	Strengths: Diverse PIP contexts and perspectives on deprescribing; theory-informed analysis using Theoretical Domains Framework to identify barriers and enablers Limitations: Only PIP perspective considered; analysis used data from interviews focused on the whole intervention process rather than exclusively on deprescribing

Alves 2019[19]	Service evaluation 10,405 patient reviews over 5 years	Care homes in Somerset	Medication review by primary care pharmacists linked to GP practices	teamwork, and time restraints (environmental context and resources). Belief that the negatives of deprescribing outweigh benefits regarding certain medications (beliefs about consequences) acted as a barrier. Pharmacists made 23,955 interventions (mean 2.3 per patient) from the 10,405 patient reviews undertaken. 16.1% of interventions were related to safety. Potential drug cost savings were estimated at £812,441 over 5 years, of which £431, 493 (53%) was attributed to deprescribing	Medication reversible a wide range of interversible commonly involved appreciation of a revision and monitoring of research of the contributes to the contributes and contributes an	Strengths: Collection of data from 'real world' implementation of intervention over 5 years Limitations: No control group, cost saving estimates not based on full
Baqir 2017[20]	Retrospective evaluation of quality improvement project 422 residents in 20 care homes	Care homes in two CCG areas in North East England	Medicines optimisation by a pharmacist acting independently or jointly with a GP. Shared decision making with the patient or their advocate	Of the 422 patients reviewed, 298 (70.6%) had at least one medicine deprescribed with 704 medicines (19.5%) being stopped. There was no statistically significant difference between pharmacist only and pharmacist plus GP in terms of deprescribing. Assuming that each medicine stopped would have been taken for another year, annualised cost savings were estimated at £65,471	Medicines optimisation reviews can lead to a reduction in polypharmacy for care home residents through and deprescribing process. Patients' medicine regiments by ere simplified and deptimised while making financial sagings for the NHS	economic evaluation Strengths: Compares two approaches to delivering medicatio review Limitations: Short- term uncontrolled study; intervention quality/fidelity not measured

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Birt 2021[21]	Mixed methods process evaluation of cluster RCT Intervention arm comprised 25 triads: Care homes (staff and up to 24 residents), GP and pharmacist Independent Prescriber (PIP); 22 PIPs contributed data	Care homes in England, Scotland and Northern Ireland	Integration of PIPs into care homes to assume central responsibility for medicines management	All stakeholders reported some benefits from PIPs having responsibility for medicine management and identified no safety concerns. PIPs reported an increase in their knowledge and identified the value of having time to engage with care home staff and residents during reviews. PIPs recorded 566 clinical interventions, many involving deprescribing; 93.8% of changes were sustained at 6 months. For 284 (50.2%) residents a medicine was stopped, and for a quarter of residents, changes involved a medicine linked to increased falls risk. Qualitative data indicated participants noted increased medication safety and improved resident quality of life. Contextual barriers to	The intervention of the in	Strengths: Involved three UK nations wi differing healthcare systems; used study records to supplement qualitative data Limitations: Intervie participants may no be representative; limited access to car home residents
Howard 2014[11]	Process evaluation of data from cluster RCT	General practice surgeries in an 80 km	Pharmacist-led IT enabled intervention (PINCER).	implementation were apparent in the few triads where PIP was not known to the GP and care home before the trial. In three triads, PIPs did not deliver the intervention. Pharmacists judged 72% (95% CI 70, 74; 1463/2026) of cases of hazardous medicines management to be clinically	Recommendations & Boadly Recommendations & Boadly hique de l	Strengths: Uses data from a large cluster RCT

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	radius	Patients	relevant. Pharmacists	acceptable to 😝 s and led to	Limitations:
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intervention	Manchester	risk from	interventions in 74% (95% CI 73,	majority of cases. It seems	record detailed
and 36 control	and	hazardous	76; 1516/2038) of cases and	likely that the appreach used by	reasons for their
practices; 1946	Nottingham	medicines	1685 actions were taken in 61%	the PINCER phaging a ists could	judgements and
patients		management	(95% CI 59, 63; 1246/2038) of	be employed by S S S S S S S S S S S S S S S S S S	these were not peer
identified as at		were	cases; 66% (95% CI 64, 68;	other practice and acists	reviewed
risk in		identified	1383/2105) of interventions	following appron at training.	
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practices		Browser	were completed and 5% were	e supplied the state of the sta	
		software to	accepted by GPs but not	oaded perieu t and c	
		search GP	completed at the end of the		
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		records.	remaining recommendations	nini Nies	
		Intervention	were rejected or considered not	ing.	
		practices were	relevant by GPs.	AI AI	
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			and recommended interventions to GPs		omjopen-2023-081934 on 7 A by copyright, including for u	
Jeffries 2017[13]	Qualitative realist evaluation Interviews: 3 GPs, 2 CCG pharmacists; Focus groups: 2 GPs, 4 community pharmacists, 4 patients, 4 practice managers	CCG in the South of England	Electronic Medicines Optimisation System (EMOS). The EMOS is intended to facilitate clinical audits of prescribing activity to identify patients at risk of adverse drug events (ADEs)	Effective use of the EMOS depended upon engagement with the system, the flow of information between different health professionals centrally placed at the CCG and those locally placed at individual general practices, and upon adaptation of work practices to facilitate the use of the system. The use of the system was undermined by perceptions of ownership, lack of access, lack of knowledge and awareness, and time pressures.	The use of an electric points medicines optimized from system may improve medicines optimized from system may improve medicines optimized from system may improve medicines of system is of an ADE. To feet the potential benefit of the potential benefit of the potential stake olders and with a wide of stakeholders. Edigating with all potential stake olders and users prior to implementation might allay perceptions that the system is owned control to more seen of the potential benefits.	Strengths: Realist methodology enabled detailed examination of how the EMOS was used and its potential effects Limitations: Study involved only one CCG so may not be representative
Jeffries 2018[12]	Qualitative process evaluation 28 staff members from 23 general practices (9 GPs, 12 pharmacists, 7 other GP staff)	43 general practices in Salford, Greater Manchester	Electronic audit and feedback surveillance dashboard to identify patients potentially at risk of hazardous prescribing or	Engagement with the dashboard involved a process of 'sensemaking' by pharmacists. The intervention helped to build respect, improve trust and develop relationships between pharmacists and GPs. Collaboration and communication between pharmacists and clinicians was primarily initiated by	Medicine opting sation in primary care may be enhanced by the implementation of a pharmacist-ledgeleef ronic audit and feedback system. This intervention established a rapid learning health system that enabled data from electronic health records to be used to make changes in practice to improve patient cape.	Strengths: Use of Normalization Process Theory as a framework to understand implementation Limitations: Evaluation team als developed the intervention; numb of follow-up

			monitoring of medicines	pharmacists and was important for establishing the intervention.	981934 on 7 ncluding fo	interviews was limited
Lane 2020[22]	Qualitative focus groups and interviews 85 (72 in focus groups and 13 in semi-structured interviews)	Care homes (4 sites in England (2), Scotland and Northern Ireland)	Integration of PIPs into care homes to take responsibility for medicines management	A PIP service was seen as offering benefits for residents, care homes and doctors but stakeholders raised challenges including agreement on areas where PIPs might prescribe, contextual barriers in chronic disease management, PIPs' knowledge of older people's medicine, and implementation barriers in integrated teamworking and ensuring role clarity. Introducing a PIP was welcomed in principle but conditional on: a clearly defined PIP role communicated to stakeholders; collaboration between doctors, PIPs and carehome staff; and dialogue about developing the service with residents and relatives.	The overarching the person of the search was the search was the search other's systems. In pattern of systems in advantaged from http://bmjopen.bmj.com/ on June implementing and data mining, Al training, and similar tecling.	Strengths: Purposively selected sample; use of TDF as a framework to analyse data Limitations: Data relate to proposed service model in advance of implementation
Madden 2022[14]	Qualitative interview study 10 newly appointed pharmacists working in primary care	General practice in England	Structured medication review (SMR) for people at risk of harm or medication- related problems	SMR implementation was largely delegated to individual pharmacists. Established pharmacists appeared more ready for implementation than newly appointed staff. New pharmacists were learning about working in primary care settings and tended to follow procedures	Early implementation of SMRs did not match the internation of providing patients with a holistic review and shared decision-making. The authors identified an important opportunity cost of SMR implementation with internation with adequate skills	Strengths: based on detailed, in-depth interviews Limitations: Authors note interviews need to be complemented by data on actual

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	networks (PCNs) in Northern England; 10 established pharmacists working in GP practices in other PCNs			with which they were already familiar, particularly when they lacked patient-facing expertise. Implementation was affected by ongoing backlogs and workforce issues in general practices	development, tedining for uses related to 1	practice and longer term follow-up
Peek 2020[15]	Interrupted time series 43 general practices covering 235,595 people in Salford, Greater Manchester	General practice in England	Pharmacist-led Safety Medication dASHboard (SMASH). SMASH involved (1) training of clinical pharmacists to deliver the intervention; (2) a web- based dashboard providing actionable, patient-level feedback; and (3) pharmacists reviewing individual at- risk patients,	The study used an interrupted time series analysis of rates (prevalence) of potentially hazardous prescribing and inadequate blood-test monitoring, comparing observed rates post-intervention to extrapolations from a 24-month pre-intervention trend. At baseline, 95% of practices had rates of potentially hazardous prescribing (composite of 10 indicators) between 0.88% and 6.19%. The prevalence of potentially hazardous prescribing reduced by 27.9% (95% CI 20.3% to 36.8%, <i>p</i> < 0.001) at 24 weeks and by 40.7% (95% CI 29.1% to 54.2%, <i>p</i> < 0.001) at 12 months after introduction of SMASH. The rate of inadequate blood-test monitoring (composite of 2 indicators) reduced by 22.0%	The SMASH interpretation was associated with the second code rates of potentially hazardous prescribing and the sustained over 1/2 months for prescribing but hotor monitoring of medication. The variation in rates of mazardous prescribing between practices. Agence Bibliographique de l'Aquidelines xhtml	Strengths: Authors noted pragmatic design, evaluation or clinically relevant outcomes and large number of practices taking part Limitations: Not a randomised study so possibility of unrecognised confounding cannot be excluded

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Rodgers 2022[16]	Multiple interrupted time series 393 general practices covering approximately 3 million patients	General practice in the East Midlands region of England	and initiating remedial actions or advising GPs on doing so. Pharmacist-led IT intervention to reduce hazardous prescribing (PINCER)	(95% CI 0.2% to 50.7%, <i>p</i> = 0.046) at 24 weeks; the change at 12 months (23.5%) was no longer significant (95% CI –4.5% to 61.6%, <i>p</i> = 0.127). After 12 months, 95% of practices had rates of potentially hazardous prescribing between 0.74% and 3.02%. Successive groups of general practices received the PINCER intervention between September 2015 and April 2017. Eleven prescribing safety indicators were used to identify potentially hazardous prescribing and data were collected over a maximum of 16 quarterly time periods. PINCER was implemented in 370 (94.1%) of 393 general practices; data were successfully extracted from 343 (92.7%) of these practices. For the primary composite outcome, the PINCER intervention was associated with a decrease in the rate of hazardous prescribing of 16.7% (adjusted odds ratio (aOR) 0.83, 95% confidence interval (CI) 0.80 to 0.86) at 6	The PINCER interpretation of the process related to the process rela	Strengths: Suggests intervention was implemented successfully in routine practice and was associated with significant reductions in hazardous prescribing Limitations: The authors adjusted for calendar time and practice, but since this was an observational study, the findings may have been influenced by unknown confounding factors or behavioural changes unrelated to
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Syafhan 2021[17]	Individual RCT 356 patients at risk of medication-related problems (MRPs) from 8 GP practices	General practice in England (6 practices) and Northern Ireland (2)	Medicines optimisation with shared decision-making and agreed treatment goals. Intervention repeated at 2 and 4 months, building on progress towards agreed goals	months and 15.3% (aOR 0.85, 95% CI 0.80 to 0.90) at 12 months post-intervention. The unadjusted rate of hazardous prescribing reduced from 26.4% to 20.1% at 6 months and 19.1% at 12 months. The greatest reduction was for hazardous prescribing indicators related to GI bleeding Median number of MRPs per intervention patient at 6 months was reduced from 3 to 0.5 (p < 0.001) in patients who received the full intervention schedule. Medication Appropriateness Index (MAI) scores were reduced (medications more appropriate) for the intervention group, but not for control group patients. Using the intention-to-treat (ITT) approach, the number of telephone consultations in intervention group patients was reduced and different from the control group. No significant differences between groups were found in unplanned hospital admissions, length of hospital stay, number of A&E attendances or outpatient visits. The mean overall healthcare	mjopen-2023-081934 on 7 August 2024. Downloage tree of energy by copyright, including for uses related to text and detailed training, and similar technologies. The pharmacism medications are in a cost-effective of the pharmacism medications in a cost-effective of the pharmacism medication medica	the PINCER intervention. Data were also not collected for all practices at 6 and 1. months post- intervention Strengths: Pragmati randomised design Limitations: Sample smaller than planned; high loss to follow-up; MRP analysis only covere patients who attended 3 appointments

Thayer 2021[23]	Service evaluation 160 care home residents with intellectual disabilities (ID)	Care homes for people with ID in the Wirral	Pharmacist review of residents' medicines and lifestyle risk factors between November 2019 and May 2020.	cost per intervention patient fell from £1041.7 ± 1446.7 to £859.1 ± 1235.2 (<i>p</i> = 0.032). Cost utility analysis showed an incremental cost per patient of − £229.0 (95% CI − 594.6, 128.2) and a mean QALY gained of 0.024 (95% CI − 0.021 to 0.065),. indicative of a health status gain at a reduced cost (2016/2017). The 160 residents were prescribed 1207 medicines, 74% were prescribed 35 medicines and 507 interventions/recommendations were made, averaging 3.3 per resident. The highest proportion (30.4%) were lifestyle risk related, while changing and stopping medicines accounted for 17.9% and 12.8%, respectively. Of the recommendations discussed with GPs/psychiatrists, 86% were accepted.	There was constitutions of versidents and antique of pharmacists of which the residents and antique of pharmacists. Wider adoptionand pharmacist review models could have benefits for the residential populations with populations with the popul	Strengths: Drew on skills of pharmacists from different sectors to address wide range of care needs; recommendations addressed national priorities Limitations: Study limited to one CCG area; limited access to patient records; observational study with no control/comparator arm
Twigg 2015[24]	Service evaluation	Community pharmacies in England	Four or More Medicines (FOMM) support	Of 620 patients recruited, 441 (71.1%) completed the 6-month study period. Pharmacists made 142	By focussing on patents over the age of 65 years with four or more medicines, community pharmacists can improve	Strengths: Large sample of patients and providers; use of

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620 patients	service.	recommendations to prescribers	medicine adhe சூnc சூand patient	validated outcome
(aged over 65	Patients were	in 110 patients, largely centred	quality of life. and an	measures
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prescribed ≥ 4	participate in	prescribing of	or u	Limitations: No
medications)	the service by	NSAIDs, PPIs or duplication of	is ea	control/comparator
	the	therapy. At follow-up, there was	st 2	group; authors note
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	pharmacist	increase in medicine adherence	ext supplies	their GP during the
	held regular	and quality of life. Cost per	and and	study period;
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Appendix Table 2: TIDieR Lite for UK pharmacist studies

Intervention name and study ID(s)	By whom	What	Where	Intensity August 2 r uses reig	How often
CHIPPS Alharthi 2023[18]; Birt 2021[21]; Lane 2020 [22]; Bond 2020[25]; Holland 2023[29]	Trained pharmacist independent prescribers (PIPs). The training programme comprised 2 days of face-to-face instruction, time in practice to develop relationships with the GP and care home staff, and to address any self-assessed competency gaps supported by a mentor, and a formal final sign-off by a GP independent of the research	PIP, in collaboration with the care home resident's GP, assumes responsibility for managing the medicines of the resident, including: • Reviewing resident's medication and developing and implementing a pharmaceutical care plan • Assuming prescribing responsibilities • Supporting systematic ordering, prescribing and administration processes with each care home, GP practice and supplying pharmacy where needed • Providing training in care home and GP practice • Communicating with GP practice, care home,	Participating care homes	PIPs committed a me service. atted to work to delign the service approximatel to work to delign the service approximatel to the service appro	PIPs visited care homes weekly over 6 months

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		supplying community pharmacy and study team		1934 on 7 cluding for	
Care home medication reviews Alves 2019[19]	Primary care pharmacists and GPs in Somerset CCG area and CCG staff	Medicines optimisation visits to care homes. Primary care pharmacists visited homes on behalf of GP practices; GPs could participate in visits or hold discussions with pharmacists prior to the visit; screening of safety interventions was done by CCG pharmacist leads	Care homes with and without nursing in Somerset	The time and level of support allocated for the service was a proof with the respective CCG Locality Pharmacist Manager and influence Pharmacist Was a sengate Pharmacist of factors such as engage Pharmacists' availability; skills and pharmacists' availability;	The aim of the programme was to offer at least one visit to as many care homes as possible (appears to be one visit per year but not explicitly stated)
Shine Medication Optimisation Project Baqir 2017[20]	Pharmacists together with care home nurses and other members of the multi-disciplinary team (MDT), including GPs and mental health professionals as needed. Two different models: pharmacists made prescribing decisions (as part of shared decisionmaking) independently or in conjunction with GPs	A notes based, pharmacist-led review of medicines, where the Northumbria 3Q approach was applied to each medicine, that is, was there an indication, was the indication appropriate and was it safe?. Additionally, medicines missing that could be beneficial (eg, START medicines) were identified. This was followed by a MDT meeting where the information from the pharmacist-led review was discussed and an action plan was formulated. Whenever possible, the final decisions were made with patients and their families. After the review,	Care homes in North East England	Intensity of intervent intervent intensity of in	Once, as a funded quality improvement (QI) project

		the project database was updated to show medicines taken before review, medicines stopped, started or changed and any other interventions made.		-081934 on 7 August 20 Enseign , including for uses rela	
PINCER Howard 2014[11]; Rodgers 2022[16]	Pharmacists specifically trained to deliver the intervention; GPs, other practice staff and pharmacy technicians involved in implementation	Computer systems of general practices are searched to identify patients at risk of potentially hazardous prescribing using a set of prescribing safety indicators. Pharmacists then provide an educational outreach intervention where they meet with GPs and other practice staff to: Discuss the search results and highlight the importance of the hazardous prescribing identified using brief educational materials. These feedback sessions were to be held straight after running the searches and then at regular intervals. Agree on an action plan, retained within the practice, for	General practices	When PINCER was relief out in the East Midlands, time spend of the local Medicine of the local Medicine of the local Medicine of the mining, .	Data collected quarterly up to 12 months after starting the intervention[16]

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		reviewing patients identified as high risk and improving prescribing and medication monitoring systems using root cause analysis Pharmacists (sometimes supported by pharmacy technicians) then work with, and support, general practice staff to implement the agreed action plan, sometimes making the necessary changes themselves		mjopen-2023-081934 on 7 August 2024. Downloaded from http://brr Enseignement Superieur (ABES) . by copyright, including for uses related to text and data mining, AI		
Eclipse Live (electronic medicines optimisation system (EMOS)) Jeffries 2017[13]	Developed by a private company (Eclipse Solutions) and made available to stakeholders (including doctors, pharmacists, practice managers and patients) by a CCG in the South of England	Web-based user interface which securely extracts patient data from general practice patient records. Accessed separately from the GPs' clinical systems, it allows different stakeholders access to real time anonymized patient data including medical histories of diagnoses, prescribed medications and test results. The EMOS is intended to facilitate clinical audits of prescribing activity to identify patients at risk of ADEs, or not appropriately monitored.	General practices covered by the participating CCG	Not reported (quidelines xhtml	study)	Not reported (qualitative study)

		Patients can access the system through a "Patient Passport"		081934 or including	
Safety Medication dASHboard (SMASH) Jeffries 2018[12]; Peek 2020[15]; Jeffries 2020[26]	Clinical pharmacists working in general practices and other general practice staff	Pharmacists were trained to deliver the intervention and apply root cause analysis techniques to identify, explore, resolve, and prevent medication errors in partnership with general practice staff. Pharmacists and practice staff were given access to a web-based, interactive dashboard that provided feedback on 12 indicators of potentially hazardous prescribing. The dashboard also provided practice-level summary data as well as educational material.	General practices covered by the participating CCG	Practices interacted with the dashboard a median of 12.0 (internal artile range, 5.0–15.2) times per month during the first quarties of use. Over time, dashboard used by the sitioned towards regular but towards regular but towards regular but towards of 5.5 [3.5–15.5] and resolve new cases. The frequency of dashboard use was higher in practices with a larger number of at-risk patients. Al training, Al training, and the same of the sa	Dashboard was updated daily. Frequency of use varied by practice and over time (see previous column)
Structured Medication Review (SMR) Madden 2022[14]; Stewart 2021[27]	Clinical pharmacists within general practice primary care networks (PCNs)	Invited, personalised, holistic review of all medicines and their benefits to health for people at risk of harm or medicine-related problems	General practices	Reviews are recommended to be scheduled for at least 30 minutes to allow time for shares decision-making echnologies.	Once
Medicines optimisation intervention	GP practice-based pharmacists operating as part of the wider primary care team	Each pharmacist received 2 days of intensive specialist training	Eight general practices in four regions of the UK	Initial meeting with furt ber appointments available of 2 and 4 months building on patient progress towards agreed goals of appointment of the second of the	Once per patient (up to three appointments)

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on medicines optimisation (including training on motivational interviewing). The intervention included: review of patient records prior to meeting; medication history; individual medicines optimisation plan that could include recommending/making changes to medication regimens (in collaboration with GPs), personalised education and counselling on medication management, the correct use of medication administration devices and lifestyle factors; and an agreed list of treatment goals. Pharmacists could also refer patients to another health professional within the practice. Having completed the intervention, the pharmacist produced a short report for the patient's GP outlining actions taken and any further recommendations requiring GP input		August 2024. Downloaded from http://bmjopen.bmj.com/ on June 9, 2025 at / Enseignement Superieur (ABES) . or uses related to text and data mining, Al training, and similar technologies.
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Collaborative	Community and	Medicine review using a	Care homes	507 interventions/recommendations for	Once
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		Learning Disability Mortality	intellectual	r u	
Γhayer		Review (LeDeR) report.	disabilities	7 August 2024. Enseignem for uses related	
2021[23]		Pharmacists visited care homes		reig	
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		access to the care record held		ade	
		by the Specialist Mental Health		l da	
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		prevention, dysphagia risk and		lar n J	
		lifestyle risk issues, especially		tec	
		smoking. Finally, pharmacists		hno hno	
		were asked to detail actions		20;	
		taken/advice provided, any		yies	
		recommendations made and		,, ±	
		make referrals, as necessary.		Ge	
		Following the review, GP		http://bmjopen.bmj.com/ on June 9, 2025 at Agence Bibliographique de I ES) . nining, Al training, and similar technologies.	
		surgeries and psychiatrists were		<u>B</u>	
		contacted by the pharmacists		blic	
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		to arrange a review of their		<u> </u>	

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		ВМ.	J Open	bmjopen-2023-081934 on 7	
		recommendations. As the pharmacists were not prescribers, decisions on accepting recommendations were made by the resident's GP/psychiatrist (after reviewing the resident's full clinical record) in consultation with the pharmacists		mjopen-2023-081934 on 7 August 2024. Down Enseignement St by copyright, including for uses related to tex	
Four or More Medicines (FOMM) support service Twigg 2015[24]	Community pharmacists and pharmacy team members	Pharmacists were trained via distance learning and face to face, which included how to use the various different tools and assessments. Training was then cascaded to other pharmacy members. Patients were invited to participate in the service by the community pharmacy team. The pharmacist held regular consultations with the patient and discussed risk of falls, pain management, adherence and general health. They also reviewed the patient's medication using STOPP/START criteria.	Participating community pharmacies	Pharmacist time established at 25 minutes for initial code at 25 minutes for monthly minutes for monthly minutes for quarter minutes for quarter minutes for quarter minutes, All training, and similar technologies.	LO consultation,
		For peer review only - http://bmjope	en.bmj.com/site/	gence Bibliographique de l about/guidelines.xhtml	

MMAT quality assessment results

Reference Screening questions Type of study MMAT questions and answers Alharthi 2023[18] S1. Are there clear research questions? Yes S2. Do the collected data allow to address the research questions? Yes Alves Alves 2019[19] Alves S2. Do the collected data allow S2. Do the collected data allow Type of study Qualitative 1.1. Is the qualitative approach and precisive description and facilitators) 1.2. Are the qualitative data colleging methods adequate to address the research question? Can't tell (second for analysis of existing data) 1.3. Are the findings adequately derived from the data? Yes 1.4. Is the interpretation of results of the collection analysis and interpretation? Yes (analysis and interpretation? Yes) Alves S1. Are there clear research questions? Yes S2. Do the collected data allow S2. Do the collected data allow S3. Are there participants representation of the target population? home residents) 3.1. Are the participants representation of the target population? home residents) 3.2. Are measurements appropriate regarding both the outcome a intervention (or exposure)? Yes 3.3. Are there complete outcome			ВМ	J Open
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3.5. During the study period, is the intervention administered (or e		questions: res		
occurred) as intended: can't ten (intergentions not externally valual				
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Birt 2021[21]	S1. Are there clear research	Mixed methods	5.1. Is there an adequate rational from sing a mixed methods design to
	questions? Yes		address the research question? Y र्ट्डि (वृष्ट्रिalitative and quantitative data
			relevant to process evaluation)
			5.2. Are the different components of the study effectively integrated to
	S2. Do the collected data allow		answer the research question? Yes () () () () () () () () () (
	to address the research		5.3. Are the outputs of the integratient of qualitative and quantitative
	questions? Yes		components adequately interpret & 🛱 🛱 🕉 es (see discussion)
			5.4. Are divergences and inconsist இத்த between quantitative and
			qualitative results adequately add हुई ई d? Yes (page 11 column 2)
			5.5. Do the different components 👸 🛱 🕏 study adhere to the quality
		4	criteria of each tradition of the met நீண்க involved? Yes
Howard	S1. Are there clear research	Quantitative	4.1. Is the sampling strategy relevant by address the research question?
2014[11]	questions? Yes	descriptive	Yes ta Yes
		N _L	4.2. Is the sample representative $\frac{1}{2}$ target population? Yes (all
			interventions recorded)
	S2. Do the collected data allow		4.3. Are the measurements appropriate? Yes
	to address the research		4.4. Is the risk of nonresponse bia 2 Yes (data from intervention arm
	questions? Yes		only)
			4.5. Is the statistical analysis appropriate to answer the research
			question? Yes
Jeffries	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach appropriate to answer the research
2017[13]	questions? Yes		question? Yes (explored factors perceived to affect adoption and
			implementation)
			1.2. Are the qualitative data collection methods adequate to address the
	S2. Do the collected data allow		research question? Yes (interview ട്ട് ane focus groups)
	to address the research		1.3. Are the findings adequately derived from the data? Yes (context-
	questions? Yes		mechanism-outcome groups identோed பூ
			1.4. Is the interpretation of results sufficiently substantiated by data? Yes
			1.5. Is there coherence between qualigative data sources, collection,
			analysis and interpretation? Yes (supported by use of realist analysis)
Jeffries	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach apprograiate to answer the research
	questions? Yes		question? Yes (explored factors perceized to affect adoption and
2018[12]	questions: res		implementation) <u>a</u>

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			023-08 ght, in
	S2. Do the collected data allow		1.2. Are the qualitative data collection methods adequate to address the research question? Yes (interviews)
	to address the research		1.3. Are the findings adequately derived from the data? Yes
	questions? Yes		1.4. Is the interpretation of results sufficiently substantiated by data? Yes (supported by relevant quotes)
			1.5. Is there coherence between $q_{\mu} = \tilde{q}_{\mu} \tilde{q}_{\mu}$ it is the data sources, collection,
			analysis and interpretation? Yes (Supposited by use of Normalisation Process Theory)
Lane	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach approa
2020[22]	questions? Yes		question? Yes (gather opinions abet groposed service)
		4	1.2. Are the qualitative data collegion methods adequate to address the
			research question? Yes (focus groழு தீற்d interviews with different staff
	S2. Do the collected data allow		groups at different sites)
	to address the research		1.3. Are the findings adequately derived from the data? Yes
	questions? Yes		1.4. Is the interpretation of result substantiated by data? Yes
			(supported by relevant quotes) \succeq
			1.5. Is there coherence between callinative data sources, collection,
			analysis and interpretation? Yes (ﷺ) analysis and interpretation?
			Framework) G
Madden	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach approach approach to answer the research
2022[14]	questions? Yes		question? Yes (pharmacists' experience of SMR implementation)
			1.2. Are the qualitative data collection methods adequate to address the
			research question? Yes (interviews with newly employed and established
	S2. Do the collected data allow		pharmacists)
	to address the research		1.3. Are the findings adequately derived from the data? Yes
	questions? Yes		1.4. Is the interpretation of results sufficiently substantiated by data? Yes
			(supported by relevant quotes) g at
			1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation? Yes (supply red by thematic analysis)
Peek	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes
2020[15]	questions? Yes	randomised	(general practices and their patients)
_0_0[10]	4.00.00.00		3.2. Are measurements appropriate regarding both the outcome and
			intervention (or exposure)? Can't tell For intervention)
			phique d

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to address the research questions? Yes Sample Sample		S2. Do the collected data allow		3.3. Are there complete outcome at a Yes
Solution		to address the research		3.4. Are the confounders account of in the design and analysis? No
Solution		questions? Yes		(small risk of unmeasured confounding)
Substitute Sub				3.5. During the study period, is the intervention administered (or exposure
questions? Yes S2. Do the collected data allow to address the research questions? Yes S3. Are there complete outcome and intervention (or exposure)? Can't ger intervention) S4. Are the confounders accounted on the design and analysis? No (Small risk of unmeasured confounding) Syaffian S2. Do the collected research questions? Yes S4. Are there clear research questions? Yes S5. Do the collected data allow to address the research questions? Yes S5. Do the collected data allow to address the research questions? Yes Thayer 2021[23] Thayer S5. Do the collected data allow to address the research questions? Yes S5. Do the collected data allow to address the research questions? Yes S5. Do the collected data allow to address the research questions? Yes S5. Do the collected data allow to address the research questions? Yes S5. Do the collected data allow to address the research questions? Yes S5. Do the collected data allow to address the research questions? Yes S5. Do the collected data allow to address the research questions? Yes S5. Do the collected data allow to address the research questions? Yes S5. Do the collected data allow to address the research questions? Yes S6. Are there clear research questions? Yes S7. Are the research questions? Yes S8. Are there clear research questions? Yes S9. Do the collected data allow to address the research questions? Yes S6. Are the research questions? Yes S7. Are the research questions? Yes S8. Are there clear research questions? Yes S9. Are the research questions? Yes (adetographs regarding both the outcome and intervention (or exposure)? Yes (detographs recorded for each review and associated outcomes) S8. Are there complete outcome data? Yes (all specified outcomes) S9. Are the resonance and their patients and their patients and their patients with intellectual disputients.				occurred) as intended? Can't tell (இத்தைentions not externally validated)
3.2. Are measurements appropriate grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Can't is grading both the outcome and intervention (or exposure)? Ves (details precorded for each review and associated outcomes) 3.2. Are there complete outcome data? Yes (all specified outcomes) 3.3. Are there complete outcome assignment in the design and analysis? No (So and 12-month data not collected for moll practices) 3.4. Are the confounders accountered for in the design and analysis? No (small risk of unmeasured confounders) 3.5. During the study period, is the grading both the outcome and intervention (or exposure)? Yes (details precorded for each review and associated outcomes) 3.6. Are there complete outcome data? Yes (all specified outcomes) 3.7. Are the participants adhere to intervention? Yes (continued) 3.8. Are the proups a manufacture of tell (prevention) and the participants adhered? Can't tell (prevention) and tell (Rodgers	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes
S2. Do the collected data allow to address the research questions? Yes Syafhan 2021[17] Syafhan 2021[27] Syafhan 2021[27] Syafhan 2021[28] Syafhan 2021	2022[16]	questions? Yes	randomised	(general practices and their patien) Section (general practices and their patien)
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to address the research 3.3. Are there complete outcome data Yes (all specified outcomes				
m m				·
questions? Yes reported) ===				\blacksquare
		questions? Yes		
3.4. Are the confounders accounted for in the design and analysis? No				
(uncontrolled before/after study) হু				
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			3.5. During the study period, is the intervention administered (or exposure
			occurred) as intended? Yes (one-o∰ review mainly based on records)
Twigg	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Can't tell
2015[24]	questions? Yes	randomised	(no indication of attempts to recru ⊉ a ≥ presentative sample)
			3.2. Are measurements appropria இது arding both the outcome and
			intervention (or exposure)? Yes (de la recorded for intervention
	S2. Do the collected data allow		components and associated outco沿海最辰
	to address the research		3.3. Are there complete outcome वैन्द्रें दें Can't tell (limited response for
	questions? Yes		resource use outcomes)
			3.4. Are the confounders account கூடு ரோ in the design and analysis? No
		A	(uncontrolled before/after study) and en ad
			3.5. During the study period, is the intervention administered (or exposure
			occurred) as intended? Can't tell (ခြို့တွဲမြို့သ. 30% withdrawal rate)
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			ence Bibliogr



PRISMA 2020 Checklist

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Section and Topic	Item #	Checklist item	Location where item is reported
TITLE		ng or	
Title	1	Identify the report as a systematic review.	Title
ABSTRACT		L D	
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge. Provide an explicit statement of the objective(s) or question(s) the review addresses.	Introduction (pp4-5)
Objectives	4	1 Tovide all explicit statement of the objective(s) of question(s) the review addresses.	Methods (p6)
METHODS	<u> </u>		
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Methods (p6)
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted.	Methods (p7)
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used	Supplementar file
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation to large seed in the process.	Methods (p7)
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each the processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Methods (pp7 8)
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which study were sought (e.g. for all measures).	Methods (pp7 8)
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, and beginning sources). Describe any assumptions made about any missing or unclear information.	Methods (pp7 8)
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Methods (p8)
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	See methods (p8)
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	See methods (p8)
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing sum ary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	N/A (summary tables only)
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used 2	N/A
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Methods (p8)
	13f	Describe any sensitivity arralyses conducted to assess hobjustness of the syrithesized tresults lines.xhtml	N/A



PRISMA 2020 Checklist

Pag	ge 71 of 71		BMJ Open BMJ Open by cred by jopen Cred by jopen Cred by jopen	
1 2	PRISM	ИА 20	by copyrigh 22:	
3 4 5	Section and Topic	Item #	Checklist item	Location where item is reported
6 7	Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting asses).	N/A
8 9	Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Results (p8)
10	RESULTS		\$ t 2	
11 12 13	Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to t	P10 and Figure 1
14 15		16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Supplementary table
16 17	Study characteristics	17	Cite each included study and present its characteristics.	Tables 1-4
18 19	Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Supplementary table
20 21 22 23	Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) and (c) are the stimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Tables 1-4 where available and appropriate
23	Results of	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Results (p22)
25 26	syntheses	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summate estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the	N/A
27		20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
28		20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
29 30	Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
31 32	Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Results (p22)
33	DISCUSSION	-	ogi 2	
34 35 36	Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Discussion (especially p27)
37 38 39		23b	Discuss any limitations of the evidence included in the review. Bibli	Discussion (especially p26)
40 41		23c	Discuss any limitations of the review processes used.	Discussion (pp27-28)
42 43		23d	Discuss implications of the results for practice, policy, and future research.	Discussion (pp28-29)
44	OTHER INFORMA	TION		
45 46	Registration and	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Title page

			BMJ Open	cted by	136/hr	Page 72 of 71
1 2	PRISI	MA 20		y copyrigh	36/hm ionen-2023	
3 4 5	Section and Topic	Item #	Checklist item	t, incluc		Location where item is reported
6	protocol	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	ing	2	Title page
7		24c	Describe and explain any amendments to information provided at registration or in the protocol.	for :	7	P9
9	Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in	žhed.	⊋ view.	Title page
10 11	Competing interests	26	Declare any competing interests of review authors.	nseign es rela	184 20	Title page
12 13 14	Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forr studies; data used for all analyses; analytic code; any other materials used in the review.	ement S	ta extracted from included	Data sharing statement (p30)
15 16 17	From: Page MJ, McKe	nzie JE, I	Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting system For more information, visit: http://www.prisma-statement.org/	uper⊯ur (xt and dat	views. BMJ 2021;372:n71. doi:	10.1136/bmj.n71
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BMJ Open

Pharmacist-led primary care interventions to promote medicines optimisation and reduce overprescribing: a systematic review of UK studies and initiatives

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Journal:	BMJ Open
Manuscript ID	bmjopen-2023-081934.R2
Article Type:	Original research
Date Submitted by the Author:	11-Jun-2024
Complete List of Authors:	Chambers, Duncan; The University of Sheffield, ScHARR; Preston, Louise; University of Sheffield, ScHARR Clowes, Mark; University of Sheffield, ScHARR Cantrell, Anna; University of Sheffield, ScHARR Goyder, Elizabeth; ScHARR, University of Sheffield
Primary Subject Heading :	General practice / Family practice
Secondary Subject Heading:	Pharmacology and therapeutics
Keywords:	Primary Care < Primary Health Care, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Patient-Centered Care, Systematic Review

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Pharmacist-led primary care interventions to promote medicines optimisation and reduce overprescribing: a systematic review of UK studies and initiatives

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Conflict of interest: The authors have no conflicts of interest to declare

Total word count: Main text including tables 8040

Keywords: Overprescribing, deprescribing, medicines optimisation, primary care, pharmacist, United Kingdom, scoping, systematic

Funding and registration: NIHR Health Services & Delivery Research
Programme (project number NIHR135767). PROSPERO registration number
CRD42023396366. The full protocol is available online at
https://fundingawards.nihr.ac.uk/award/NIHR135767

Abstract

Objectives: To systematically review and synthesise evidence on the effectiveness and implementation barriers/facilitators of pharmacist-led interventions to promote medicines optimisation and reduce overprescribing in UK primary care.

Design: Systematic review

Setting: UK primary care

Methods: We searched MEDLINE, Embase, CINAHL PsycINFO and The Cochrane Library for UK-based studies published between January 2013 and February 2023. Targeted searches for grey literature were conducted in May 2023. Quantitative and qualitative studies (including conference abstracts and grey literature) that addressed a relevant intervention and reported a primary outcome related to changes in prescribing were eligible for inclusion. Quality of included studies was assessed using the Multiple Methods Appraisal Tool (MMAT). We performed a narrative synthesis, grouping studies by publication status, setting and type of data reported (effectiveness or implementation).

Results: We included 14 peer reviewed journal articles and 11 conference abstracts, together with four case study reports. The journal articles reported 10 different interventions, five delivered in general practice, four in care homes and one in community pharmacy. The quality of evidence was higher in general practice than in care home settings. It was consistently reported that the intervention improved outcomes related to prescribing, although the limited number of studies and wide range of outcomes reported made it difficult to estimate the size of any effect.

Implementation was strongly influenced by relationships between pharmacists and other health and care professionals, especially GPs. Implementation in care homes appeared to be more complex than in general practice because of differences in systems and 'culture' between health and social care

Conclusions: Pharmacist-led interventions have been reported to reduce overprescribing in primary care settings in the UK but a shortage of high-quality evidence means that more rigorous studies using high-quality designs are needed. More research is also needed in community pharmacy settings; to assess intervention effects on patient outcomes other than prescribing; and to investigate how reducing overprescribing can impact on health inequalities.

Registration: PROSPERO [CRD42023396366].

Strengths and limitations of this study

We included evidence often excluded from systematic reviews to get as full a picture as
possible of how pharmacist-led interventions are implemented and sustained in practice as
well as their characteristics and effectiveness.

• Some review processes were performed by a single reviewer and meta-analysis was not feasible.



Introduction

This evidence review was performed to support implementation of the National Overprescribing Review for England (NOR; see below)) by examining research on pharmacist-led overprescribing interventions in UK primary care settings. Pharmacists are trained to provide advice and support to patients and other health professionals, pharmacist independent prescribers (PIPs) have existed since 2006 and patients are increasingly asked to consider the community pharmacy as a first source of support for minor health conditions. Alongside community pharmacies, many general practices have pharmacists as members of the practice team. Pharmacists, working with GPs and other healthcare professionals, are thus well placed to support interventions directed towards medicines optimisation and the reduction of overprescribing. Such interventions include carrying out structured medication reviews directly with patients and carers and/or reviewing data from patient records. The aims and objectives of the review are outlined below, following a brief clarification of terminology.

Overprescribing has been defined as 'the use of a medicine where there is a better non-medicine alternative, or the use is inappropriate for that patients' circumstances and wishes'[1]. Overprescribing is often related to the concept of problematic polypharmacy, where harmful effects result from the prescription of multiple medications. However, there is no agreed definition of polypharmacy and patients with complex health conditions may require multiple medications.

Medicines optimisation is an umbrella term for interventions designed to ensure that medicines are used safely and effectively, producing the best possible outcomes for patients. In this context, deprescribing refers to the process of stopping medications that are no longer appropriate to a patient's needs. Deprescribing is a response to overprescribing and problematic polypharmacy and involves collaboration between health professionals and patients and/or carers to ensure shared decision-making. Shared decision-making with patients and/or carers is fundamental to successful medicines optimisation[2] but the need for time and resources to ensure that this takes place can create barriers to service delivery. Another related term, medicines reconciliation, is a more technical process to ensure consistency between prescription records and the medications the patient is actually receiving and taking. The terminology around overprescribing and other forms of medicines misuse was recently reviewed by Singier et al[3]. Medication review involves examining a patient's prescriptions as a whole and is separate from measures to reduce inappropriate prescribing of specific medications or types of medication such as antibiotics or proton pump inhibitors.

Overprescribing can cause direct harm to patients in a variety of ways. It has been estimated that about 6.5% of hospital admissions are caused by harmful effects of medication, rising to 20% for people aged over 65[1]. In addition to physiological harms, long-term use of some medications can lead to dependency and problems when attempting to withdraw the medication.

Issues relating to prescribed medication can arise from a whole range of causes, including patients requiring treatment for multiple conditions, lack of co-ordination between different health professionals or organisations and failures of communication between health professionals and patients (for example failing to gather information because of time constraints on appointments). Availability of new medications and increasing numbers of people living with long-term conditions such as arthritis and diabetes have resulted in patients being prescribed more medications and continuing to take them for long periods of time, often for life. The average number of prescription

items per head of population doubled between 1996 and 2016, and over 75% of prescriptions are repeat prescriptions[1].

Pharmacists are thus well placed to support processes of medicines optimisation, which involve them working closely with medical professionals (particularly GPs), commissioners of health care and patients. The report of the National Overprescribing Review for England, published in 2021, provides numerous examples and case studies[1].

The National Overprescribing Review (NOR) for England was set up in 2018 to evaluate the extent of overprescribing in the NHS and recommend measures to reduce it, particularly in primary care. A review of existing research (overview of systematic reviews) was commissioned to support the national review[4]. The NOR identified a need for a more consistent and effective approach to medication review, which requires both the identification of effective interventions and an understanding of the factors that need to be addressed in terms of organisational and cultural barriers to implementation. The national review's recommendations included changes to systems (patient records, transfers of care and clinical guidance) and culture (reduced dependence on medication and support for shared decision-making), as well as the appointment of a National Clinical Director for Prescribing[1].

This evidence review was commissioned to support implementation of the NOR recommendations by examining research on pharmacist-led overprescribing interventions in UK primary care settings. Our focus on pharmacist-led interventions complements recent research on deprescribing in the UK context. The TAILOR evidence synthesis sought to identify how best to support deprescribing in older people living with multimorbidity and polypharmacy. The authors concluded that effective deprescribing requires 'attention to providing an enabling infrastructure, access to data, tailored explanations and trust'[5]. More recently, Radcliffe et al. conducted a realist review and synthesis examining multidisciplinary medication review and deprescribing interventions for older people in primary care[6]. This study identified a number of key mechanisms that could contribute to the design of effective interventions, including integration of pharmacists into the multidisciplinary team delivering the intervention. Pharmacist-led interventions could fall within the scope of both of these studies, but characterisation of the evidence base is required to support the application of insights derived from these more general, theory-based reviews.

We aimed to assess the effects of relevant interventions on outcomes related to prescribing, identify key characteristics of the interventions and examine barriers and facilitators to implementation in routine practice. A further aim was to assess the quality of the evidence base and identify priorities for further research.

Methods

i.

Review aims and objectives

We aimed to perform a systematic review of published literature and published or informally published evaluations reporting UK-based, pharmacist-led interventions for overprescribing, including the following components:

- A review and synthesis of outcomes of effective interventions
- ii. A review of the characteristics of effective interventions using the TIDieR framework
- iii. Evaluation of the UK evidence base in terms of quality and risk of bias
- iv. Identification of case study examples of effectively implemented interventions in the UK

Inclusion and exclusion criteria

Inclusion criteria for the review were as follows

- Population/setting: UK primary care
- Intervention: Pharmacist-led interventions aimed at review and optimisation of prescribed medications
- Comparator: Not required
- Outcomes: Studies had to report a primary outcome related to changes in prescribing.
 Secondary outcomes were other patient and health service outcomes, including but not limited to changes to type of medicines prescribed, quality of life, hospital admissions and deaths.
- Study design: Quantitative and qualitative studies were eligible for inclusion, with no
 exclusions based on study design or quality. Reports of local initiatives published as grey
 literature reports or conference abstracts were included to give a fuller picture of activity
 across the NHS.
- Other: Studies published in English between January 2013 and February 2023

We excluded interventions aimed at reducing overprescribing of specific medications or types of medication, e.g. antibiotics or proton pump inhibitors. Studies of children and young people were also excluded.

Search methods

The literature search harnessed economies of scale by identifying primary studies for inclusion in this review and reviews for inclusion in a scoping review for internal use to inform the wider project. Searches were conducted by an information specialist (MC) in order to identify published and unpublished evidence on primary care interventions to reduce overprescribing.

A first phase of database searches was run in February 2023 to retrieve relevant peer-reviewed literature. Searches were designed around the following concepts:

PROBLEM	INTERVENTION	SETTING
Overprescribing;	Deprescribing;	Primary Care
Inappropriate prescribing;	Structured medication review;	(including international terms
polypharmacy	medication reconciliation; medicines optimisation; shared decision making; personalised care	for primary care where relevant)

While we are aware of the Morel filter (2022) for identifying studies of deprescribing[7], our focus was specifically on a primary care setting. Search strategies are provided in supplementary file 1.

Searches covered the databases MEDLINE, Embase, CINAHL, PsycINFO and The Cochrane Library and were limited to studies published since 2013 and in OECD countries with healthcare systems similar to the UK.

Phase 2: grey literature

A further phase of targeted searches was conducted in May 2023 to identify unpublished or "grey" literature. This involved searching for the case studies identified by the National Overprescribing Review (to identify any which had produced a report or evaluation), and then searching the Overton.io platform for pharmacist-led deprescribing/overprescribing and medicines optimisation.

Searches were complemented by input from stakeholders (internal and external topic advisers) to minimise the risk of missing any other relevant evidence.

Study selection

Records retrieved by the literature search were stored in a shared EndNote library and deduplicated. Screening for inclusion at the title level was performed by single reviewers after piloting of a test set. Reviewers could refer records to another team member in the event of uncertainty and a 20% sample of records was screened by a second reviewer to validate title level inclusion decisions.

Screening for inclusion at the abstract and full text level was performed by pairs of reviewers acting independently. Disagreements were resolved by discussion among the reviewers involved (AC, DC and LP). A good level of agreement was achieved, values of kappa between pairs of reviewers ranging from 0.67 to 0.96. Reasons for exclusion at the full text stage were recorded.

Data extraction

Data extraction tables and summary tables were developed in Microsoft Word. Extraction was performed by a single reviewer, with a 10% sample being checked for consistency and accuracy. In addition to standard data extraction fields (study design/sample size, setting, intervention, key findings and strengths/limitations), we used the TIDieR Lite framework to collect information on the features of interventions reported as 'successful' to determine whether service commissioners and providers should consider specific factors when commissioning/delivering services. TIDieR Lite is a simplified version of the TIDieR (Template for Intervention Description and Replication) checklist [8].

Quality assessment

Methodological quality of peer reviewed journal articles was assessed using the Mixed Methods Appraisal Tool (MMAT) version 2018[9]. The tool includes screening questions and methodological quality questions for different study designs (qualitative, randomised trials, non-randomised quantitative studies, descriptive studies and mixed methods). Quality assessment results were combined with identified strengths and limitations (including those reported by study authors) to characterise the contribution of individual studies and groups of studies to the overall evidence base.

Data synthesis

We performed a narrative synthesis of the included studies using text and tables to describe study and intervention characteristics in line with methodological and reporting guidelines[10, 11]. We initially grouped studies by publication status, considering peer-reviewed journal articles (regardless of study design and quality) separately from conference abstracts and case studies. Within these three categories, we grouped studies by setting (general practice, care homes or community settings). We also distinguished between studies reporting effectiveness of interventions and those reporting implementation of interventions (e.g. qualitative studies and process evaluations). In view of study heterogeneity and reporting limitations, effectively implemented interventions were defined as those where the study authors' conclusions indicated that the service was regarded as a success and was planned to continue or be expanded.

Studies reported a wide variety of outcomes using diverse effect measures. For this reason we did not attempt to calculate a standardised metric to compare effect sizes across outcomes. The synthesis used a 'vote-counting' method (number and proportion of studies reporting positive, negative or neutral outcomes), prioritising prescribing-related outcomes over patient and other outcomes. Reported effect measures and associated 95% CIs were recorded in the text and tables. Tables of study characteristics and findings were presented alphabetically by author for consistency. While reporting results from all study designs we prioritised stronger study designs (experimental and quasi-experimental) over those of uncontrolled observational studies. In terms of exploring heterogeneity, the structure of the synthesis allowed consideration of potential modifiers including study design, study quality and setting. Intervention components and aspects of implementation were examined using modifications of existing frameworks, the component analysis was prespecified in the review protocol.

We did not use the GRADE approach to assess certainty of evidence because of its emphasis on randomised trials and downgrading of other study designs. Instead we distinguished between controlled and uncontrolled studies, identified areas of consistency and inconsistency and highlighted areas of particularly limited evidence (e.g. settings or outcomes represented by single studies). A similar approach has been used by team members in previous reviews[12].

Public involvement

The review was supported by a public panel who provided feedback on public perceptions that informed the review and are reflected in the Discussion.

Variations from protocol

We used Tidier Lite instead of the full TIDieR framework. This was because the full framework is designed to allow the replication of interventions and therefore goes beyond the degree of detail required for evidence synthesis. The scoping review of reviews referred to in the protocol was not completed (see @Search methods' above).

Results

Results of literature search

The PRISMA flow diagram (Figure 1) summarises the study selection process. After screening 1774 records at the title and abstract stage and 215 full-text articles, we included 14 published articles, 11 conference abstracts and four case study reports. The majority of exclusions were of studies conducted outside the UK, with a smaller number excluded because the intervention was not pharmacist—led or the article did not report empirical data. Characteristics of the included studies are reported in the following sections.

Please insert Figure 1: PRISMA flow diagram near here

Research studies

Study characteristics

Study characteristics are summarised in Table 1, with full data extraction tables in supplementary file 2. The 14 publications reported on ten interventions, of which five were delivered in general practice (seven publications[13-19]), three in care homes for older people (five publications[20-24]), one in care homes for people with intellectual disabilities (ID) [25] and one in community pharmacies[26].

All the interventions involved medication review in some form. Distinctive features of interventions included use of IT to identify patients for review[13-15, 17, 18]; a key role for pharmacist independent prescribers in medication management in care homes[23, 24]; and employment of pharmacists by groups of general practices (primary care networks, PCNs) to provide a holistic patient-centred service specified by NHS England[16]. Intervention characteristics are considered in more detail below.

Study designs used included one individual RCT[19] and two cluster RCTs (CHIPPS[20, 23] and PINCER[13]), although the primary publications of the latter two trials fell outside the time period covered by this review. Two studies used an interrupted time series (ITS) design[17, 18] and five used qualitative approaches[14-16, 20, 24]. One study was a mixed methods process evaluation[23]. The remaining studies were described as service evaluations or quality improvement reports with an uncontrolled before vs. after design [21, 22, 25, 26].

Included studies reported a wide range of outcomes (Table 1). For further analysis, see below under 'effects of interventions' and 'Implementation/system issues, respectively. None of the studies reported details of participants other than age and sex, making it difficult to assess equity, diversity and inclusion across the evidence base.



Table 1: Summary of research study characteristics

Гable 1: Sumi	mary of research study charac	BMJ Open		bmjopen-2023-081934 on 7
asie 1. 3 aii	mary of research seady charac			34 on 7 .
Reference	Population	Intervention	Study design	Ogtrome measures
	controlled studies	1	1	es n
Howard 2014[13]	Pharmacists delivering intervention	IT-enabled pharmacist-led review to reduce medication errors	Cluster RCT (PINCER trial)	T语语 数ken to complete reviews; re 如此nended interventions and whether treggere implemented
Peek 2020[17]	General practice patients with one or more risk factors for hazardous prescribing or inadequate blood test monitoring	Pharmacist-led Safety Medication dASHboard (SMASH) intervention	Interrupted time series analysis	R
Rodgers 2022[18]	General practices in the East Midlands	Pharmacist-led IT intervention (PINCER)	Multiple interrupted time series	Ingles ors of potentially hazardous prescribing
Syafhan 2021[19]	Patients in participating GP practices at risk of MRPs	Pharmacist-supplemented care focusing on medication optimisation	Individual RCT	Namber of medication related problems (Namber of medication inappropriateness pairs dinical outcomes and costs
Quantitative	uncontrolled studies		C 1.	a Z.
Alves 2019[21]	Care home residents	Medication review by primary care pharmacists linked to GP practices	Service evaluation (5 year uncontrolled study)	Ingerventions by pharmacist (including deprescribing and changes to perscriptions)
Baqir 2017[22]	Care home residents	Medication review by pharmacist with or without GP	Retrospective analysis of data from QI programme	Number and type of medications stopped
Thayer 2021[25]	Care home residents with intellectual disabilities	Collaborative service initiative involving community pharmacists and a specialist mental health pharmacist providing review of medicines and lifestyle risk factors	Service evaluation	interventions/recommendations and acceptance by GPs and psychiatrists
		For peer review only - http://bmjopen.bmj.con	n/site/about/guidelines.xh	Biliographique de I

			bmjopen-2023-	
Twigg 2015[26]	Patients over 65 prescribed four or more medications	Community pharmacist consultation including medication review using STOPP/START rules	Service evaluation	Namber of recommendations; falls, needication adherence, quality of life and costs at 6 months
<i>Qualitative/</i> Alharthi 2023[20]	Care home residents	Deprescribing by pharmacist independent prescriber	Qualitative interviews with participants in a cluster RCT (CHIPPS study)	Basing and facilitators to deprescribing rusers and facilitators to deprescribing related to te
Birt 2021;[23]	Care home residents	Pharmacist independent prescribers responsible for medicines management (CHIPPS)	Mixed methods process evaluation	Pਸ਼੍ਰੇ ਚੁੱਕੀ vities, perceived benefits and bæਵਿਵਾਲ to implementation
Jeffries 2018[14]	Pharmacists delivering intervention, GPs and CCG staff	Pharmacist-led intervention involving the use of an electronic audit and feedback surveillance dashboard to identify patients potentially at risk of hazardous prescribing or monitoring of medicines in general practice	Qualitative interviews	The Best related to implementation of the interpretation and role of practice partiacists and others At joing the partial process of the
Jeffries 2017[15]	Stakeholders in general practice and CCG	Electronic medicines optimisation system	Qualitative realist evaluation	Stage tions to support implementation of the system
Lane 2020[24]	Doctors, pharmacists, care-home managers and staff, residents and relatives	Pharmacist independent prescriber service	Qualitative focus groups and interviews	Percented benefits of the service and barriess and facilitators to implementation
Madden 2022[16]	Pharmacists working in general practice within PCNs	Structured medication review (SMR) service within Primary Care Networks	Qualitative interview study	Time mes related to early implementation of Son R service

Table 2: Summary of studies reporting effects of interventions

Tahle 2: Sum	mary of studies reporti	ng effects of interven	BMJ Open	bmjopen-2023-081934 on 7
Reference	Intervention	Setting	Study design and sample size	Outcome measure and effect size
Alves 2019[21]	Medication review	Care homes	Service evaluation 10,405 patient reviews over 5 years	Interventions by pharmacise 2024. Down to te
Baqir 2017[22]	Medication review	Care homes	Retrospective evaluation of quality improvement project 422 residents in 20 care homes	Number and type of medical has stopped 19.5% reduction in number of medicines being prescribed relative to baseline the stopped from http://
Peek 2020[17]	Safety medication dashboard	General practice	Interrupted time series 43 general practices covering 235,595 people in Salford, Greater Manchester	Potentially hazardous prescribing (composite of 10 indicators) Potentially hazardous prescribing reduced by 27.9% (95% CI 20.3% to 36.8%, $p < 0.001$) at 24 very and by 40.7% (95% CI 29.1% to 54.2%, $p < 0.001$) at 12 months.
Rodgers 2022[18]	Pharmacist-led IT- assisted intervention (PINCER)	General practice	Multiple interrupted time series 393 general practices covering approximately 3 million patients	Indicators of potentially hazardous prescribing The PINCER intervention was a sociated with a decrease in the rate of hazardous prescribing of 6.2% (adjusted odds ratio (aOR) 0.83, 95% confidence interval (CS 0.89 to 0.86) at 6 months and 15.3% (aOR 0.85, 95% CI 0.80 to 0.80) at 12 months post-intervention
Syafhan 2021[19]	Pharmacist-led medicines optimisation	General practice	Individual RCT 356 patients at risk of medication-related	Medication-related problems (\P RP); Medicines Appropriateness Index (MAI) Median number of MRPs per intervention patient at 6 months was reduced from 3 to 0.5 ($p < 0.00$) in patients who received the full

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			nroblems (MADDs) from 0		modiantions mass
			problems (MRPs) from 8 GP practices	appropriate) for the intervention group, but not fo	or control group.
Thayer 2021[25]	Review of medicines and lifestyle risk factors	Care homes for adults with intellectual	Service evaluation 160 care home residents with ID	Pharmacist interventions/recommendations and a and psychiatrists and psychiatrists religion 200	cceptance by GPs
Twigg 2015[26]	Community pharmacist consultation including medication review	disabilities (ID) Community pharmacies	Service evaluation 620 patients (aged over 65 years and prescribed ≥ 4 medications	Number of recommendation and of life and costs at 6 month (ABES). Number of recommendation of life and costs at 6 month (ABES). Number of recommendation on June 9, 2025 at Agence Bibliographique de l'ambient superieur (ABES). Number of recommendation on June 9, 2025 at Agence Bibliographique de l'ambient superieur (ABES). Number of recommendation on June 9, 2025 at Agence Bibliographique de l'ambient superieur (ABES). Number of recommendation on June 9, 2025 at Agence Bibliographique de l'ambient superieur (ABES).	lherence, quality
		For peer review	only - http://bmjopen.bmj.cc	m/site/about/guidelines.xhtml	1

Intervention characteristics

Table 2 in supplementary file 2 summarises characteristics of the included interventions using the TIDieR Lite checklist. The table includes limited data extracted from studies cited by included studies but not themselves included in the review [27-29].

The pharmacists involved in delivering the interventions were variously described as pharmacist independent prescribers[23]; trained pharmacists and pharmacy technicians[13, 18]; primary care pharmacists[21]; clinical pharmacists working in general practice[15-17]; GP practice-based pharmacists working as part of a wider primary care team[19]; community and specialist mental health pharmacists[25]; and community pharmacists and pharmacy team members[26]. One study simply referred to 'pharmacists'[15].

Four interventions were explicitly stated to require training of pharmacists to deliver them[13, 19, 23, 26]; the extent of training was described for three of these[19, 23, 26]. Training pharmacists to deliver the PINCER intervention was described in a separate paper[13]. Interventions were delivered with other primary care team members depending on the setting of the study and in some cases with staff employed by clinical commissioning groups (CCGs). In particular, only the CHIPPS study involved pharmacists with the power to prescribe medication independently; in other studies recommendations were passed to the patient's GP or another medically qualified professional for implementation. Shared decision-making with patients and/or families was specifically reported for three interventions[16, 19, 22].

Reporting of interventions varied between studies. Most studies reported the process of medication review including patient selection for review and the review itself in more detail than resulting follow-up actions. Two qualitative studies reported limited details of the review process[14, 16], although a service specification was available for the NHS England structured medication review (SMR) investigated by Madden et al.[16]. For studies where the intervention was primarily directed at improving medication review processes using general practice data[13-15], it was unclear whether there was a standard process to discuss findings with the patient and make changes to their prescriptions. All studies reporting on effectiveness of medication reviews stated that the person undertaking the review had access to relevant patient records[17-19, 21, 22, 25, 26].

Intensity of interventions was also variably reported. In the CHIPPS study, PIPs committed a minimum of 16 hours/month to deliver care to approximately 20 care home residents[27]. Madden et al. reported that SMR appointments were recommended to allow at least 30 minutes for review and shared decision-making[16]. The medicines optimisation intervention evaluated by Syafhan et al. involved up to three meetings between patient and pharmacist[19], while the FOMM study in community pharmacies estimated times of 25 minutes for initial consultation, 10 minutes for monthly review and 11 minutes for quarterly review[26]. Other studies reported that time and level of support allocated to interventions varied between and within CCG areas depending on local resources and priorities[18, 21]. Another measure of intervention intensity was the number of recommended actions, averaging 3.3/resident in care home residents with intellectual disabilities[25].

Most included studies reported on a single round of medication reviews with variable periods of follow-up. As noted above, some interventions required multiple interactions between pharmacists and patients.

Effects of interventions

 Seven studies reported on effects of pharmacist-led interventions in some form (Table 2): three in general practice[17-19], three in care homes[21, 22, 25] (including one in a care home for people with ID[25]) and one in community pharmacies[26].

The strongest evidence for the effectiveness of interventionscame from the studies in general practice. The interrupted time series (ITS) studies of Peek et al.[17] and Rodgers et al.[18], which used indicators of inappropriate prescribing to identify patients for intervention, reported significant decreases in inappropriate prescribing at 6 and 12 months after intervention (Table 2). Estimated reductions were larger in Peek et al. (27.9% and 40.7%) compared with Rodgers et al. (16.7% and 15.3%)[17, 18]. The 95% confidence intervals of the two studies at 12 months did not overlap, suggesting some uncertainty about the magnitude of the effect. The randomised trial by Syafhan et al.[19] preferentially recruited patients based on prescription of six or more medications and a history of recent unplanned hospital admission. The intervention was associated with a reduction in medication-related problems in those who completed the full programme (up to three appointments) and an improvement in MAI scores.

Of the three studies set in care homes, only Baqir et al. reported a direct effect on prescribing associated with medication review, a 19.5% reduction in number of prescribed medicines[22]. Alves et al.[30] reported on pharmacist interventions and potential financial savings over 5 years. In the one year reported in detail, 24.5% of interventions involved deprescribing. Potential drug cost savings were estimated at £812,441 annually, of which £431, 493 (55%) was attributed to deprescribing. The study of Thayer et al.[25] differed from the others in involving care home residents with intellectual disabilities. There was a high level of polypharmacy at baseline and pharmacists made an average of 3.3 interventions/recommendations per resident, of which 12.8% involved deprescribing. A large majority of pharmacist recommendations were accepted by GPs/psychiatrists caring for the residents.

The one study in a community pharmacy setting recruited patients aged 65 or older who were prescribed four or more medications[26]. Of 620 patients recruited, 441 (71.1%) completed the 6-month study. Pharmacists made 142 recommendations related to 110 patients, largely dealing with potentially inappropriate prescribing of NSAIDs and PPIs or duplication of therapy. The study also reported a significant decrease in falls and improvements in medication adherence and quality of life at follow-up.

The review included two publications from the CHIPPS Care Homes Independent Pharmacist Prescriber Study) trial[20, 23] but the paper reporting effectiveness and safety results from this cluster RCT[31] was published too late for formal consideration for inclusion in our review. The primary outcome was rate of falls, with Drug Burden Index (DBI) being one of the secondary outcomes. Fall rate at 6 months did not differ significantly between intervention and control groups

but DBI was lower in the intervention group (mean 0.66 vs. 0.73; adjusted rate ratio 0.83, 95% CI 0.74 to 0.92).

Implementation/system issues

Seven studies provided quantitative and/or qualitative evidence on factors affecting implementation of pharmacist-led interventions, of which four were performed in general practice[13-16] and three in care homes[20, 23, 24].

The general practice studies focused on different parts of the implementation pathway. Two dealt with implementation of IT systems to support detection of potentially hazardous prescribing[14, 15]; one was a process evaluation of the PINCER trial[13]; and one focused on implementation of structured medication reviews as recommended by NHS England in routine practice[16]. The studies of IT-supported interventions were broadly positive about the potential for implementation and sustainability, but the study of NHS England's SMR programme concluded that its early implementation failed to deliver the planned holistic and patient-centred approach.

Other evidence

Conference abstracts

We included 11 conference abstracts (Table 4), of which two were earlier reports of studies subsequently published as full papers[30, 32]. All of the included abstracts focused on intervention effects on prescribing and related outcomes.

Five abstracts reported research in general practice, of which three involved patients with polypharmacy identified from the overall practice population[33-35]. As a group, these three abstracts provided weak evidence of associations between pharmacist-led medication reviews and changes in medication and cost savings together with high levels of patient satisfaction (Table 3),

Two abstracts reported on selected general practice populations. The only comparative study in this group reported that patients living with frailty who were reviewed by a pharmacist as part of a multi-disciplinary team review had a reduction in total medications compared with a control cohort[36]. When patients recently discharged from hospital were reviewed by a pharmacist working in their general practice, 16 out of 35 had changes made to their medication, with 74% of changes involving deprescribing[37].

Turning to studies performed in care homes, two abstracts by Doherty et al. (2020)[38, 39] evaluated an intervention entitled Medicines Optimisation in Older People (MOOP) which involved case management by pharmacists. The authors reported that inappropriate prescribing (based on the MAI) was highly prevalent at baseline *84%) but declined significantly following the intervention. Swift et al. reported that a team comprising pharmacists and pharmacy technicians who both performed medication reviews and supported care home staff significantly reduced inappropriate polypharmacy (measured by prescribing quality indicators) between 2024 and 2017[40]. For care home residents receiving palliative care, structured medication reviews involving shared decision-

making were associated with high rates of changes to medication (1787 suggested changes from 574 reviews, 76% of which were implemented) and associated cost savings[41].

Grey literature case studies

We included reports of four case studies reporting on local initiatives in three areas of England (see Table 4). Details of all case studies may be found in Annex C of the National Overprescribing Review report[1]. Case studies were submitted by NHS organisations (mainly CCGs) and included varying amounts of data on intervention characteristics, support for implementation and outcome measures. Three interventions were delivered in general practice and one in care homes. The initiative developed by Swale CCG was distinctive in using pharmacy technicians to review less complex cases, although the initiative was targeted at patients considered high-risk for ADRs. Although not classified as research, such case studies can provide useful data on implementation of interventions and outcomes achieved in routine practice



Table 3: Summary of studies published as conference abstracts

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Table 3: Summa	ry of studies published a	as conference abstracts		bmjopen-2023-081934 on 7
Reference	Population	Intervention	Study design	Outcome measuges and key findings
Alves 2016[30]	Care home residents	Medication review by primary care pharmacists linked to GP practices	Service evaluation (retrospective analysis and interviews)	Interventions by 獨議論macist; barriers and facilitators A total of 2916 in which depresed by represented 22%
Bryant 2019[33]	Primary care patients taking ten or more medications	Polypharmacy clinics in GP surgeries	Service evaluation (retrospective data analysis)	Reductions in property ing; cost savings; hospital admissions avoiding a pril 2017 to March 2018, 370 patients reviewed and £50,766.63 save to the pril to December 2018 were 209 and £13, 202, respectively
Chauhan 2022[37]	Patients recently discharged from hospital	Post-discharge medication review by clinical pharmacist linked to GP practice	Formative service evaluation (uncontrolled)	Medication changed following review 16/35 patients had medications changed; 74% (25/34) of changes were medications stopped
Din 2020[34]	Patients referred by GPs	Polypharmacy review clinics led by pharmacist independent prescriber with shared decision-making	Service evaluation (uncontrolled)	Changes to medication, feedback from patients and MDT Pharmacist medication reviews were effective, with positive feedback received from patients and members of the MDT. Deprescribing and inhaler counselling were the most common interventions.
Din 2022[36]	Primary care patients living with frailty	Frailty review involving pharmacist as part of MDT	Comparative cohort	Changes in medigation (including cholinergic burden), practice contact so had a reduction in total number of medications when compared with non-intervention cohort. Anti-choliners ic burden scores were reduced by a mean of 26%
		For peer review only - http://br	njopen.bmj.com/site/abo	ibliographique de

			BMJ Open	bmjopen-2023.
Doherty 2020a[38], 2020b[39]	Care home residents	Medicines Optimisation in Older People (MOOP) involving case management by pharmacists	Uncontrolled before/after	Inappropriate prescribing; unplanned hospital admissions; GP visits; clinical steep ventions Inappropriate prescribing was highly prevalent at baseline (84.1%) but imprever significantly from baseline (M = 14.87, SD = 13.1
Donyai 2017[35]	Patients aged at least 75 years and prescribed 15 or more medication	Pharmacist-led polypharmacy review clinic in primary care	Survey	Patient satisfaction and related outcomes Of the 166 patient strong with o returned a satisfaction questionnaire (46,500,500,500,500,500,500,500,500,500,50
Kolovetsios 2018[41]	Care home residents needing palliative care	Structured medication reviews carried out in agreement with patient, nurse, family/carer and GP	Service evaluation	Changes to medigation, estimated cost savings From January 20 B January 2018, 574 medication reviews took place of savings and savings sulting in 1787 suggested medication changes. Approximately 76% of these changes were agreed and actioned by patients' GPs, with estimated savings of 169,986.96.
Swift 2018[40]	Care home residents	Care home team (pharmacists and pharmacy technicians) delivering medication reviews and supporting care home staff	Service evaluation	Prescribing quality indicators (including reduced inappropriate polypharmacy); CQC ratings Medication reviews were completed for 749 care home residents between August 2014 and March 2017. Of the recommendation made to prescribers, 85% were accepted and resulted in a reduction in inappropriate polypharmacy
Syafhan 2019[32]	Patients in participating GP practices at risk of MRPs	Pharmacist-supplemented care focusing on medication optimisation	Individual RCT	Number of medication related problems (MRPs) and medication inappropriateness A total of 356 ad lit patients (175 control and 181 intervention) were recruited. Among 108 intervention patients who had thrue pharmacist face-to-face contacts, 346 MRPs were identified at baseline and 83 MRPs at 6 months. Median values were 3 MRPs at baseline and 1 at 6 months (p<0.001).

Table 4: Summary of selected grey literature case studies

		BMJ Open	bmjopen-2023-081934
Table 4: Summar	ry of selected grey literature	case studies	mjopen-2023-081934 on 7 by copyright, including fo
Setting	Name of initiative	Key findings	Comments
Brighton and	An evaluation of a clinical	A total of 1,300 patients were referred into the service	The targed fatient cohort of frail or older
Hove CCG	pharmacist medication	and reviewed between April 2017 and March 2018; 9%	person grangeribed polypharmacy was identified
	review service in primary	of patients were deprescribed high-risk medicines	from sea swithin GP clinical systems and
	care		through referrals from clinical practitioners,
			voluntæर्षुं पूर्व र्ह्रेd social care services
Swale CCG	Medicines Optimisation	In 2018/19, pharmacists and pharmacy technicians	Target ថ្នាំ គ្រី ទៀកigh-risk' patients
	Review Programme	reviewed 5281 patients and made 3859 interventions,	Key fear use of technicians for less complex
		37% for adverse drug reactions (ADRs). Estimated in-	cases dat Cro
		year cost savings were £239,546	n m m
NE Hampshire	Care homes pharmacist	Pharmacist accompanying GPs visiting care homes	Limited reported
and Farnham		carried out over 250 medication reviews and 800	
CCG		interventions. Average number of medicines per	mjop
		resident fell from 9.4 to 7.6	
NE Hampshire	Polypharmacy	Tool developed by Wessex AHSN was used to identify	Limited data reported
and Farnham	prescribing comparators	patients at risk of harm, resulting in significant	, and
CCG		reductions in percentage of patients aged over 75	d s
		prescribed 15 or more medications and percentage with	simila
		an anticholinergic burden score of 6 or more	
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Study quality

Quality assessment results using the MMAT are presented in supplementary file 3. The results should be read in conjunction with the study strengths and limitations (see Table 1 in supplementary file 1).

Five different checklists within the MMAT were used to assess the 14 studies. The sample included one RCT[19]; six studies were classified as quantitative non-randomised[17, 18, 21, 22, 25, 26]; one as quantitative descriptive[13]; one as mixed methods[23]; and five as qualitative[14-16, 20, 24]. All studies passed the screening questions (are there clear research questions? and do the collected data allow to address the research questions?)

The RCT by Syafhan et al. was described as a pragmatic trial and was at relatively high risk of bias for this type of design. The trial did not achieve the planned number of participants and there was a high rate of attrition (about 30%), meaning that many participants did not receive the full intervention or provide outcome data. The trial also suffered from unclear reporting: method of randomisation and whether outcome assessors were blinded was not reported, making it difficult to assess overall risk of bias.

The quantitative non-randomised studies comprised four observational studies at high risk of bias because of the absence of a control group[21, 22, 25, 26] and two large ITS studies[17, 18]. The MMAT tool identified some limitations of these studies, including some risk of confounding and incomplete outcome data in one study[18]. However, these were large studies conducted in routine practice and providing evidence of a statistically significant effect at 12 months post-intervention. The process evaluations of the CHIPPS[23] and PINCER[13] studies both scored highly on the MMAT assessment.

The qualitative studies were generally of good quality, with sufficient data presented in support of conclusions and appropriate use of frameworks and thematic analysis to organise presentation of the findings. The study by Alharthi et al.[20] was a secondary analysis of data collected for another purpose, making it unclear whether qualitative data collection methods were adequate.

Using the system applied by the authors in previous studies of complex health service interventions[12], the overall strength of evidence was classified as borderline 'stronger' (generally consistent findings in multiple studies with a comparator group) for general practice, 'weaker' (generally consistent findings in one study with a comparator group design and several non-comparator studies or multiple non-comparator studies) for care homes and 'very limited' (single study) for community pharmacies.

Effectively implemented interventions

Three research studies met the criteria for 'effectively implemented' interventions: the closely related PINCER[18] and SMASH[17] interventions in general practice and the Somerset model of medication review in care homes[21]. Further examples of effectively implemented medication review in care homes were identified among the included conference abstracts[38-41]. Case studies from Brighton and Hove and Swale CCGs appeared to report effectively implemented interventions

targeted at high-risk patients in general practice (Table 4). An evaluation of the early implementation of SMRs in primary care networks indicated that the service as provided did not match the vision of a patient-centred holistic review with an emphasis on shared decision-making[16].



.Discussion

Summary of findings

In spite of its broad inclusion criteria, this review identified a relatively small number of studies of pharmacist-led interventions in UK primary care (14 peer reviewed journal articles, 11 conference abstracts and four case studies). Overall, the bulk of evidence came from the care home sector but most of the better quality evidence was derived from studies conducted in general practice. The majority (8/14) of peer reviewed papers were published in 2020 or later, suggesting that this is a developing area of research and practice in the context of encouraging patients to consult pharmacists initially for minor conditions and to increase pharmacists' prescribing rights. It was encouraging that we identified a number of effectively implemented interventions and initiatives in both care homes and general practice.

Outcomes of effective interventions

This systematic review suggests that pharmacist-led interventions may reduce overprescribing in primary care settings in the UK, although more controlled studies are needed. The evidence is strongest for interventions implemented in general practice, where we identified a small randomised trial[19] as well as two large quasi-experimental studies (interrupted time series)[17, 18] and various uncontrolled studies and service evaluations. Evidence from care home settings was of lower quality with the exception of the CHIPPS study involving pharmacist independent prescribers working in care homes[23]. We located only one uncontrolled study based in UK community pharmacies[26].

Although the direction of reported effects was clear, the limited number of controlled studies combined with the wide range of outcomes reported makes it difficult to estimate the size of any effect. For example, the two ITS studies using similar interventions reported markedly different reductions in measures of inappropriate prescribing at 6 and 12 months after implementation of the intervention[17, 18]. Uncertainty about effect sizes is increased because many of the studies lacked a control group and the results could have been influenced by other interventions in the health and social care system, for example the Enhanced Health in Care Homes programme implemented in England. While our review focused primarily on outcomes related to prescribing, data on cost savings were also widely reported but the evidence was generally of low quality. We also found limited evidence of a link between reductions in measures of overprescribing and clinical outcomes, mainly because of lack of reporting. The CHIPPS study found no significant difference in its primary outcome of fall rate, although there was a reduction in Drug Burden Index (a secondary outcome) in the intervention group at 6 months[31].

Characteristics of effective interventions

The TIDieR Lite checklist provided a suitable structure for describing intervention characteristics for evidence synthesis purposes and this discussion follows its structure. Lack of reporting (especially of

intervention intensity/frequency) was a limiting factor, as was reporting of varying intervention information across multiple publications.

Medication reviews were undertaken by pharmacists acting independently or in conjunction with GPs or care home staff. In a study in care homes for people with intellectual disabilities, psychiatrists were also involved in review where appropriate[25]. Pharmacy technicians were also involved in the PINCER study and could potentially have a greater role in relatively straightforward medication reviews[13, 18]. The included studies reported a variety of models of employment of pharmacists, including direct employment by GP practices, CCG Medicines Optimisation Teams, PIPs and community pharmacists. PCNs support employment of pharmacists by general practices and are the route chosen by NHS England to implement its model of SMR.

A major difference between settings is the need to identify patients requiring medication review in general practice, whereas most care home residents take multiple medications and could be considered candidates for review as part of their routine health care. A key element of the PINCER[13, 18] and SMASH[17] interventions is the use of information technology to search electronic patient records efficiently across large numbers of general practices. Effective interventions were also characterised by attention to training and tools to support and sustain change in practice, e.g. an 'audit and feedback' dashboard[17].

Training of pharmacists and other staff to deliver interventions was reported to varying degrees, reflecting in part the publication channel of the research. For example, in the CHIPPS study PIPS had comprised 2 days of face-to-face instruction plus time in practice to develop relationships with the GP and care home staff. [23] Specification and provision of appropriate training will be important for future development of pharmacist-led interventions, as also highlighted by the evaluation of NHS England's SMR programme [16].

Intervention intensity is another important factor in developing and delivering interventions. For the CHIPPS study, participating PIPs committed a minimum of 16 hours/month to the service. [23] In general practice settings, NHS England recommended allowing 30 minutes for an SMR to give time for shared decision-making; this was interpreted to include time for preparation and writing-up[16]. This level of time requirement was also reported in the one study from a community setting, which estimated pharmacist time at 25 minutes for an initial consultation[26].

In terms of intensity more generally, resourcing of interventions was reported to vary between commissioning groups (CCGs) depending on staff availability and other priorities[13, 18, 21]. General practices varied in their use of a medication safety dashboard[28]. Frequency of intervention was rarely reported, reflecting the short time frame of most included studies but it seems possible that there could be an ongoing need for review as patients get older and/or their health state changes.

Quality and risk of bias

The MMAT provided a good alternative to the use of multiple tools to assess risk of bias across diverse study designs. The only randomised trial assessed was designed as a pragmatic trial[19] and the assessment confirmed a relatively high risk of bias. Publications from the CHIPPS study were included but the trial *per se* was not assessed for risk of bias because of the publication date of the main study report. Similarly, the PINCER intervention was supported by a randomised trial published in 2012, before the cut-off date for our review [42]). Well-conducted studies included in the review included large ITS studies[17, 18], process evaluations[13, 14, 23] and qualitative studies[15, 16].

Service evaluations and other lower quality evidence tended to support higher quality studies by highlighting implementation and results achieved in routine practice, although a causal relationship between intervention and outcome remains uncertain in studies without a parallel control group.

Implementation barriers and facilitators

 Implementation of pharmacist-led interventions was strongly influenced by factors affecting relationships between pharmacists and other health and care professionals, especially GPs. Given that most pharmacists are not prescribers, their recommendations around (de)prescribing need to be seen as 'legitimate' by GPs who are generally responsible for acting on the recommendations. This is facilitated by continuity at the system level, including existing links between pharmacists and GPs[23] and good access to data[14]. Jeffries et al. reported that pharmacists took the lead in developing relationships with GPs, enabling a 'learning health system'[14]. The benefits of continuity at the system level could help to explain why early implementation of the SMR programme through the relatively new medium of PCNs was reported to be less successful than initially hoped[16].

Implementation in care homes may be more complex than in general practice because of differences in systems and 'culture' between health and social care[24]. Patients and their families may be supportive of medication review or oppose it based on real or perceived benefits of medication[20].

The main message regarding implementation of pharmacist-led interventions across all settings is the need for involvement of all relevant stakeholders, preferably before starting the process of implementation, to understand the context and anticipate possible barriers[24].

Identification of effectively implemented interventions/initiatives:

Our simple criteria for 'effectively implemented' interventions/initiatives identified a number of examples published as research papers, conference abstracts or case studies (see 'Effectively implemented interventions' above). Despite limitations as research, some of the abstracts and case studies provided valuable information about how commissioners and providers had supported interventions and their commitment to continue the programme[38-41]. In other studies, despite promising results, it was unclear whether the intervention would be implemented more widely[19].

Relationship to previous research

To our knowledge, this is the first systematic review of pharmacist-led interventions and initiatives specifically in UK settings. A scoping literature search identified 20 systematic reviews published between 2014 and 2023. The most recent review covered pharmacist integration into general practice to optimise prescribing and outcomes for patients with polypharmacy[43]. The review included 23 studies, of which just three were from the UK. The conclusion that pharmacist integration probably reduced PIP and number of medicines (moderate certainty evidence) was in line with the findings of the present review. A 2016 systematic review by Riordan et al. focused on pharmacist-led interventions to optimise prescribing in older community-dwelling adults in primary care[44]. The authors concluded that pharmacist-led interventions may improve appropriateness of

prescribing but the quality of evidence was low. The review included randomised and quasirandomised studies published before December 2015, giving it limited overlap with our review.

Strengths and limitations

The UK focus is both a strength and limitation of this review. We included evidence often excluded from systematic reviews to get as full a picture as possible of how pharmacist-led interventions are implemented and sustained in practice as well as their characteristics and effectiveness. The dual focus reflects the fact that pharmacist-led medicines optimisation and deprescribing in primary care is both an area of active research and of implementation within the health care system. Nevertheless, some of the evidence is not of high quality and we have tried to be appropriately cautious in our conclusions and identified implications.

Our broad review questions and UK focus resulted in a heterogeneous group of included studies. Meta-analysis was not possible so we performed a narrative synthesis in line with appropriate guidelines[10, 11]. The review was undertaken by a small but experienced team with expertise in systematic review methods and prescribing.

Implications for service delivery

Several studies indicate that barriers to successful service delivery often arise from 'system' issues and differences in 'culture' [16, 24]. Commissioners and providers engaged in developing new pharmacist-led services should ensure equitable access to data and information to avoid perceptions of 'ownership' by certain groups at the expense of others [15]. In care homes, where medication review is an important component of health care for residents [21], implementation requires health and social care professionals to work together and 'understand each other's systems' [24]. The holistic patient-centred SMR envisaged by NHS England may require culture change/training to foster an emphasis on direct patient contact and shared decision-making. Removal of financial incentives for PCNs to carry out SMRs as reported recently (https://pharmaceutical-journal.com/article/news/nhs-england-removes-financial-incentives-for-structured-medication-reviews-in-2023-2024) may complicate delivery, although the service remains a contractual requirement.

Services have been delivered successfully through CCGs Medicines Optimisation Teams with suitable training[13, 18]. The review also found evidence that services provided by PIPs appear to be a valid alternative to approaches requiring action by GPs or other medical professionals[23].

Implications for research

A major priority for research is to further evaluate the effectiveness of medication review in community pharmacy settings and how pharmacies might be best supported to deliver the service. A related need is for research to better understand public perceptions of community pharmacies as a

setting for medication review and their pros and cons compared with alternative settings such as GP surgeries. Research is needed to support the development of the PIP role and how PIPs might best be used in combination with GPs and other professionals to support optimal prescribing across the health and care system.

Shared decision-making is key to the success of pharmacist-led interventions. Research is needed to better understand patient and family attitudes to shared decision-making in the context of deprescribing and the barriers and facilitators operating in different settings and with different professionals.

The present review focused on outcomes related to prescribing and a review of effects on patient and health system outcomes would be a logical follow-up. Finally, further research is needed to understand the effects of implementing pharmacist-led medication review in general practice on health inequalities and how to reduce unwarranted variations in service delivery between different practices or regions.

Conclusions

The evidence base for pharmacist-led interventions varies widely in terms of quality but studies have consistently reported improvements relative to a comparator group or baseline. The diversity of interventions and outcomes reported makes it difficult to generalise about effect sizes but given the reported extent of the problem, even small relative reductions could be beneficial for patients and the health and care system.

The existing evidence base requires cautious interpretation because of a shortage of controlled studies and this is particularly the case for studies in community pharmacy settings. Further rigorous evaluation of interventions, particularly those delivered in community pharmacies, is required. Although not a focus of this review, there appears to be a shortage of high-quality economic evidence to guide decision-making by service commissioners and providers.

The problems encountered in the early implementation of NHS England's SMR programme[16] suggest a need for further research on the implementation of pharmacist-led interventions. Implementation of this type of interventions requires the involvement of all relevant stakeholders, preferably before starting the process of implementation, to understand the context and anticipate possible barriers.

Funding

This work was supported by the National Institute for Health and Care Research (award ID NIHR 135767). The funder had no role in drafting the paper or approving the version to be submitted

Conflict of interest

The authors have no conflicts of interest to declare.

Disclaimer

This report presents independent research funded by the National Institute for Health and Care Research (NIHR). The views and opinions expressed are those of the authors and do not necessarily reflect those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, NETSCC, the HS&DR programme or the Department of Health and Social Care.

Contribution of authors

Duncan Chambers (submitting author and guarantor) contributed to planning the study (writing the protocol), selected studies for inclusion, assessed study quality and wrote the first draft of the paper. Louise Preston managed the review team, contributed to planning the study (writing the protocol), selected studies for inclusion, assessed study quality and commented on drafts of the paper. Mark Clowes contributed to planning the study (writing the protocol), developed search strategies, performed literature searches and wrote up the searches and search results. Anna Cantrell selected studies for inclusion, assessed study quality and commented on drafts of the paper. Elizabeth Goyder contributed to planning the study (writing the protocol) and commented on drafts of the paper. Duncan Chambers, Louise Preston, Mark Clowes, Anna Cantrell and Elizabeth Goyder have approved the version to be submitted.

Data sharing

Any additional data not included in this report and its appendices are available on request. All queries should be submitted to the corresponding author.

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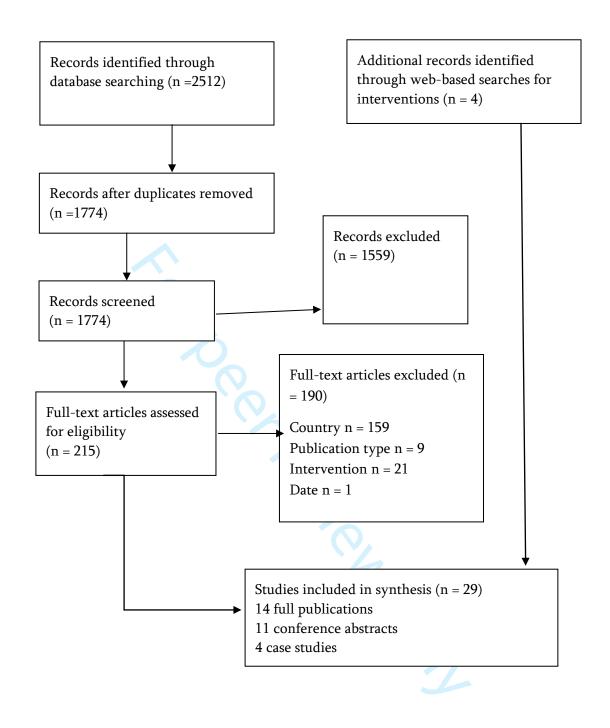
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Identification

Screening

Eligibility



SEARCH STRATEGIES in full (for Appendix / supplementary material)

Ovid MEDLINE(R) ALL <1946 to February 06, 2023>

- 1 Inappropriate Prescribing/ 4485
- 2 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or nonessential or inessential) adj3 prescri*).mp. 8188
- 3 (overprescri* or over-prescri*).mp. 1975
- 4 Polypharmacy/ or (polypharmacy or poly-pharmacy).ti,ab. 12777
- 5 1 or 2 or 3 or 4 21236

- 6 exp Primary Health Care/ or (primary health care or primary healthcare or primary care).mp. 289526
- 7 general practice/ or family practice/ 78114
- 8 (GP or general practi* or family practice or family physician* or community pharmac* or dental or dentist* or optometr* or optician*).mp. 751694
- 9 6 or 7 or 8 997387
- 10 (deprescri* or de-prescri*).mp. 2577
- 11 (structured medication review or medication reconciliation or medicine* optimi#ation or shared decision making or personalised care).mp. 16563
- 12 ((intervention* or initiative* or campaign*) adj3 (pharmacist* or pharmacy technician*)).mp. 3182
- 13 10 or 11 or 12 21842
- 14 5 and 9 and 13 540
- *Medication Errors/ and 9 and 13 232
- 16 5 and 9 and pc.fs. 835
- 17 14 or 15 or 16 1416
- 18 limit 17 to yr="2013 -Current" 1152
- 19 remove duplicates from 18 1145

Embase <1974 to 2023 Week 05>

- 1 Potentially inappropriate medication/ 2458
- 2 unnecessary prescribing/ [+NT] 51
- 3 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or nonessential or inessential) adj3 prescri*).mp. 11262
 - (overprescri* or over-prescri*).mp. 3064
- Polypharmacy/ or inappropriate polypharmacy/ or (polypharmacy or poly-pharmacy).ti,ab. 26382
- 6 1 or 2 or 3 or 4 or 5 39236
- 7 exp Primary Health Care/ or primary medical care/ or (primary health care or primary healthcare or primary care).mp. 281889
- 8 general practice/ or family practice/ 83634
- 9 (GP or general practi* or family practice or family physician* or community pharmac* or dental or dentist* or optometr* or optician*).mp. 766031
- 10 7 or 8 or 9 974647
- 11 (deprescri* or de-prescri*).mp. 3587
- 12 (structured medication review or medication reconciliation or medicine* optimi#ation or shared decision making or personalised care).mp. 28235
- 13 ((intervention* or initiative* or campaign*) adj3 (pharmacist* or pharmacy technician*)).mp. 6755
- 14 11 or 12 or 13 37710
- 15 6 and 10 and 14 813
- 16 6 and 10 and pc.fs. 308
- 17 15 or 16 1089
- 18 limit 17 to yr="2013 -Current" 903
- 19 remove duplicates from 18 886

APA PsycInfo <1806 to January Week 5 2023>

- 1 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or nonessential or inessential) adj3 prescri*).mp. 788
- 2 (overprescri* or over-prescri*).mp. 329
- 3 (polypharmacy or poly-pharmacy).mp. 3128
- 4 1 or 2 or 3 4078

- 5 (primary health care or primary healthcare or primary care).mp. 44486
- 6 (GP or general practi* or family practice or family physician* or community pharmac* or dental or dentist* or optometr* or optician*).mp. 34287
- 7 5 or 6 71196
- 8 (deprescri* or de-prescri*).mp. 336
- 9 (structured medication review or medication reconciliation or medicine* optimi#ation or shared decision making or personalised care).mp. 3969

- 10 ((intervention* or initiative* or campaign*) adj3 (pharmacist* or pharmacy technician*)).mp. 242
- 11 8 or 9 or 10 4505
- 12 4 and 7 and 11 44

Page 43 of 72		BMJ Oper	by col		
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19	S14	S11 OR S12 OR S13	ning		13,914
20 21	S13	(intervention* or initiative* or campaign*) n3 pharmacist*	, Al t		1,981
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Comment:

- ID Search Hits
- #1 MeSH descriptor: [Inappropriate Prescribing] explode all trees 234
- #2 MeSH descriptor: [Polypharmacy] explode all trees 312
- #3 ((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or "non

essential" or inessential) near/3 prescri*):ti,ab,kw 771

- #4 (overprescri* or "over-prescri*"):ti,ab,kw 161
- #5 (polypharmacy or poly-pharmacy):ti,ab,kw 1288
- #6 #1 or #2 or #3 or #4 or #5 2045
- #7 MeSH descriptor: [Primary Health Care] explode all trees 9989
- #8 MeSH descriptor: [General Practice] explode all trees 2877
- #9 MeSH descriptor: [Family Practice] explode all trees 2242
- #10 ("primary health care" or "primary healthcare" or "primary care"):ti,ab,kw 24053
- #11 (GP or "general practi*" or "family practice" or "family physician*" or "community pharmac*" or dental or dentist* or optometr* or optician*):ti,ab,kw 44879
- #12 #7 or #8 or #9 or #10 or #11 70362
- #13 MeSH descriptor: [Deprescriptions] explode all trees 68
- #14 (deprescri* or de-prescri*):ti,ab,kw 364
- #15 ("structured medication review" or "medication reconciliation" or "medicine* optimi*" or "shared decision making" or "personalised care" or "personalized care"):ti,ab,kw2425
- #16 ((intervention* or initiative* or campaign*) near/3 (pharmacist* or pharmacy)):ti,ab,kw 1559
- #17 #13 or #14 or #15 or #16 4166
- #18 #6 and #12 and #17 130

(3 reviews, 127 trials)

Data extraction tables

Table 1: Study characteristics of included research studies (full data extraction table)

Data extraction tables	bmjopen-2023-081934 on 7 August 2024 Enseignei by copyright, including for uses relate
Table 1: Study characteristics of included research studies (full data extraction table)	n 7 August 2024 Enseignen for uses relate
Study ID Study design/sample size Setting Intervention Key findings Authors	でののに でののに では でのので でのので でのので でのので でのので でのので でのので でのので でのので でのので でいるで でいるで でいるで でいるで でいるで でいるで でいるで でいるで でいるで になる になるで になる になるで になるで になるで になるで になる になる になる にな になる にな に にな に にな にな に にな に に に に に に に に に に に に に
Alharthi Secondary Care homes in England qualitative interview data Care homes Integration of PIPs into care enablers and barriers were PIP to improve interview data Care homes Integration of PIPs into care enablers and barriers were PIP to improve improve improve Practitioner (GP), care home be addressed in the proving the provinging interview data interview data improve improve interview data improve interview data improve interview data improve improve interview data improve interview data improve interview data improve interview data improve improve improve improve improve interview data improve	olvemed and care homes need by the feet of the care homes and enables that can essed to the care homes tion effectiveness The care homes of the care homes and enables that can essed to the care homes to deprescribing; theory-informed analysis using Theoretical Domain Framework to identify barriers and enablers Limitations: Only P perspective considered; analysis used data from interviews focused on the whole intervention process rather than exclusively on deprescribing The care homes of the care homes of the contexts and perspectives on deprescribing theory-informed analysis using Theoretical Domain Framework to identify barriers and enablers Limitations: Only P perspective considered; analysis used data from interviews focused on the whole intervention process rather than exclusively on deprescribing

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Alves 2019[19]	Service evaluation	Care homes in Somerset	Medication review by primary care	teamwork, and time restraints (environmental context and resources). Belief that the negatives of deprescribing outweigh benefits regarding certain medications (beliefs about consequences) acted as a barrier. Pharmacists made 23,955 interventions (mean 2.3 per patient) from the 10,405 patient	including for uses related to be primary care homes gereated to wide	Strengths: Collection of data from 'real world'
	10,405 patient reviews over 5 years		pharmacists linked to GP practices	reviews undertaken. 16.1% of interventions were related to safety. Potential drug cost savings were estimated at £812,441 over 5 years, of which £431, 493 (53%) was attributed to deprescribing	range of interversions, commonly involving service deprescribing. The service contributes to the continuous optimisation of perescribing and monitoring of redigines and offers potential drug cost savings.	implementation of intervention over 5 years Limitations: No control group, cost saving estimates not based on full economic evaluation
Baqir 2017[20]	Retrospective evaluation of quality improvement project 422 residents in 20 care homes	Care homes in two CCG areas in North East England	Medicines optimisation by a pharmacist acting independently or jointly with a GP. Shared decision making with the patient or their advocate	Of the 422 patients reviewed, 298 (70.6%) had at least one medicine deprescribed with 704 medicines (19.5%) being stopped. There was no statistically significant difference between pharmacist only and pharmacist plus GP in terms of deprescribing. Assuming that each medicine stopped would have been taken for another year, annualised cost savings were estimated at £65,471	Medicines optimisation reviews can lead to a reduction in polypharmacy for care home residents through and deprescribing process. Patients' medicine reginates and depression and depressi	Strengths: Compares two approaches to delivering medicatio review Limitations: Shortterm uncontrolled study; intervention quality/fidelity not measured

N discord					
Mixed	Care homes	Integration of	All stakeholders reported some	The intervention web generally	Strengths: Involved
methods	in England,	PIPs into care	benefits from PIPs having	implemented as intended, and	three UK nations with
process	Scotland	homes to	responsibility for medicine	well-received bੱਲ੍ਹੇ mਹੈੱst	differing healthcare
evaluation of	and	assume	management and identified no	stakeholders.	systems; used study
cluster RCT	Northern	central	safety concerns. PIPs reported	Whilst there was Medespread	records to
	Ireland	responsibility	an increase in their knowledge	deprescribing, apgregation deprescribing, apgregation deprescribing, apgregation deprescribing, apgregation deprescribing, appreciation deprescribing, appreciation deprescribing depres	supplement
Intervention		for medicines	and identified the value of	effected PIP en ୍ଲିଲ୍ଲେଲ୍ଲିnent.	qualitative data
arm comprised		management	having time to engage with care	Implementatio 🛱 प्रहेर्चे most	
25 triads: Care			home staff and residents during	effective when & offenunication	Limitations: Interview
homes (staff		O_{k}	reviews. PIPs recorded 566	pathways between BIP and GP	participants may not
and up to 24		-/ -	clinical interventions, many	had been and erice	be representative;
residents),		() _	involving deprescribing; 93.8%	previously esta ह्या हैं। हैं d.	limited access to care
GP and			of changes were sustained at 6	rom tar	home residents
pharmacist			months. For 284 (50.2%)	nin	
Independent			residents a medicine was	ing	
Prescriber			stopped, and for a quarter of	, Al	
(PIP); 22 PIPs			residents, changes involved a	tra	
contributed			medicine linked to increased	ini-	
data			falls risk. Qualitative data	ng,	
			indicated participants noted	nj.c and	
			increased medication safety and	<u>s.</u> on	
			improved resident quality of life.	mi or	
			Contextual barriers to	ar t	
			implementation were apparent	ine	
			in the few triads where PIP was	9,:	
			not known to the GP and care	202 llog	
			home before the trial. In three	ies a	
			triads, PIPs did not deliver the	, t	
			intervention.	gen	
Process	General	Pharmacist-led	Pharmacists judged 72% (95% CI	Recommendations om the	Strengths: Uses data
evaluation of	practice	IT enabled	70, 74; 1463/2026) of cases of	pharmacists were becadly	from a large cluster
data from	surgeries in	intervention	hazardous medicines	liog	RCT
cluster RCT	an 80 km	(PINCER).	management to be clinically	graphique de	
	evaluation of cluster RCT Intervention arm comprised 25 triads: Care homes (staff and up to 24 residents), GP and pharmacist Independent Prescriber (PIP); 22 PIPs contributed data Process evaluation of	process evaluation of cluster RCT Intervention arm comprised 25 triads: Care homes (staff and up to 24 residents), GP and pharmacist Independent Prescriber (PIP); 22 PIPs contributed data Process evaluation of General practice	process evaluation of cluster RCT Intervention arm comprised 25 triads: Care homes (staff and up to 24 residents), GP and pharmacist Independent Prescriber (PIP); 22 PIPs contributed data Process evaluation of General evaluation of General practice Scotland and sassume central responsibility for medicines management Pharmacist Independent Prescriber (PIP); 22 PIPs contributed data Process General practice IT enabled	process evaluation of cluster RCT Northern Ireland Northern Ireland Intervention arm comprised 25 triads: Care homes (staff and up to 24 residents), GP and pharmacist Independent Prescriber (PIP); 22 PIPs contributed data Prescriber (PIP); 22 PIPs contributed data General Process General Process evaluation of cluster RCT Northern Ireland Norteral Ireland Northern Ireland Intervention Ireland Intervention Ireland Intervention	process evaluation of cluster RCT cluster RCT Irleand Intervention arm comprised 25 triads: Care home staff and up to 24 residents), GP and pharmacist Independent Prescriber (PIP); 22 PIPs contributed data Process General Process evaluation of cluster RCT Soctland and and and and and and and and and

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	radius	Patients	relevant. Pharmacists	acceptable to 🕰 s ag d led to	Limitations:
36	around	potentially at	recommended 2105	ameliorative action the	Pharmacists did not
intervention	Manchester	risk from	interventions in 74% (95% CI 73,	majority of cases. It seems	record detailed
and 36 control	and	hazardous	76; 1516/2038) of cases and	likely that the appreach used by	reasons for their
practices; 1946	Nottingham	medicines	1685 actions were taken in 61%	the PINCER phagrage ists could	judgements and
patients		management	(95% CI 59, 63; 1246/2038) of	be employed by S	these were not peer
identified as at		were	cases; 66% (95% CI 64, 68;	other practice ង្គ្រាគ្គិកស្ថាacists	reviewed
risk in		identified	1383/2105) of interventions	following appr्के हैं हैं training.	
intervention		using Quest	recommended by pharmacists	owi	
practices		Browser	were completed and 5% were	xt a	
		software to	accepted by GPs but not	ade and	
		search GP	completed at the end of the	d fr	
		electronic	pharmacists' placement; the	ta n	
		records.	remaining recommendations	nini ES	
		Intervention	were rejected or considered not	ng.	
		practices were	relevant by GPs.	≥ N	
		assigned a	e Vien	trai	
		pharmacist		inin jen.	
		who educated	(0)	g, a	
		practice staff		j.cc	
		about		Sir	
		medication		nila	
		management		Jui te	
		and		ne s	
		recommended		from http://bmjopen.bmj.com/ on June 9, 2025 (ABES) . ata mining, Al training, and similar technologic	
		improvements		nttp://bmjopen.bmj.com/ on June 9, 2025 at iS) . ining, Al training, and similar technologies.	
		to practice.		്. ല	
		Pharmacists		Age	
		also reviewed		enc	
		cases of		Ф Ш	
		potentially		<u> </u>	
		hazardous medication		ogr	
		medication		Agence Bibliographique de	
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			and recommended interventions		081934 on 7 , including for	
					ing t	
			interventions		<u> </u>	
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		_	to GPs		· Þ	
2017[12]	Qualitative	CCG in the	Electronic	Effective use of the EMOS	The use of an e	Strengths: Realist
	realist	South of	Medicines	depended upon engagement	medicines optimie ig ig ig on system	methodology
	evaluation	England	Optimisation	with the system, the flow of	may improve n 🎘 🗗 🕰 tion safety	enabled detailed
			System	information between different	in primary care देखें सुंहुs by	examination of how
	Interviews: 3		(EMOS). The	health professionals centrally	identifying those क्रुट्संents at risk	the EMOS was used
	GPs, 2 CCG		EMOS	placed at the CCG and those	of an ADE. To fឡឺទ្រី ក្លិalise the	and its potential
	pharmacists;		is intended to	locally placed at individual	potential benefat se a	effects
	Focus groups:		facilitate	general practices, and upon	there needs to set better	
	2 GPs, 4		clinical audits	adaptation of work practices to	utilisation acro 🔄 🗃 🖆 mary care	Limitations: Study
	community		of prescribing	facilitate the use of the system.	and with a wide grange of	involved only one
	pharmacists, 4		activity	The use of the system was	stakeholders. Eaga ng with all	CCG so may not be
	patients, 4		to identify	undermined by perceptions of	potential stake b olders and users	representative
	practice		patients at risk	ownership, lack of access, lack of	prior to implent ntation might	
	managers		of adverse	knowledge and awareness, and	allay perceptio 🔁 that the	
			drug events	time pressures.	system is owned centrally and	
			(ADEs)		increase knowledge of the	
					potential beneिक्तंs. 🥞	
	Qualitative	43 general	Electronic	Engagement with the dashboard	Medicine optingsation in	Strengths: Use of
2018[12]	process	practices in	audit and	involved a process of 'sense-	primary care may be enhanced	Normalization
	evaluation	Salford,	feedback	making' by pharmacists. The	by the implementation of a	Process Theory as a
		Greater	surveillance	intervention helped to build	pharmacist-led leg ronic audit	framework to
	28 staff	Manchester	dashboard to	respect, improve trust and	and feedback sæste📆. This	understand
	members from		identify	develop relationships between	intervention es ្ពឹ abl ន្ន hed a rapid	implementation
	23 general		patients	pharmacists and GPs.	learning health system that	
	practices (9		potentially at	Collaboration and	enabled data from glectronic	Limitations:
	GPs, 12		risk of	communication between	health records to be used to	Evaluation team als
	pharmacists, 7		hazardous	pharmacists and clinicians was	make changes in præctice to	developed the
	other GP staff)		prescribing or	primarily initiated by	improve patient caæ.	intervention; numb
					raphique de l	of follow-up

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			monitoring of medicines	pharmacists and was important for establishing the intervention.	mjopen-2023-081934 on by copyright, including	interviews was limited
2020[22] for arr 85 gr in st	Qualitative ocus groups nd interviews 55 (72 in focus roups and 13 n semitructured nterviews)	Care homes (4 sites in England (2), Scotland and Northern Ireland)	Integration of PIPs into care homes to take responsibility for medicines management	A PIP service was seen as offering benefits for residents, care homes and doctors but stakeholders raised challenges including agreement on areas where PIPs might prescribe, contextual barriers in chronic disease management, PIPs' knowledge of older people's medicine, and implementation barriers in integrated teamworking and ensuring role clarity. Introducing a PIP was welcomed in principle but conditional on: a clearly defined PIP role communicated to stakeholders; collaboration between doctors, PIPs and carehome staff; and dialogue about developing the service with residents and relatives.	The overarching the promise research was the property one must "understate the property of the	Strengths: Purposively selected sample; use of TDF a a framework to analyse data Limitations: Data relate to proposed service model in advance of implementation
2022[14] in st	Qualitative Interview tudy O newly Intervied Interview I	General practice in England	Structured medication review (SMR) for people at risk of harm or medication- related problems	SMR implementation was largely delegated to individual pharmacists. Established pharmacists appeared more ready for implementation than newly appointed staff. New pharmacists were learning about working in primary care settings and tended to follow procedures	Early implementation of SMRs did not match the intention of providing patients with a holistic review and shared decisionmaking. The author identified an important opportunity cost of SMR implementation without prior adequate skills	Strengths: based on detailed, in-depth interviews Limitations: Authors note interviews need to be complemented by data on actual

	and the same and the					
l	networks			with which they were already	development, testing, and refining for uses reserves.	practice and longer
	(PCNs) in			familiar, particularly when they	refining	term follow-up
	Northern			lacked patient-facing expertise.	n 7	
	England; 10			Implementation was affected by	r u Au	
	established			ongoing backlogs and workforce	gus	
	pharmacists			issues in general practices	st 2	
	working in GP				7 August 2024. I Enseigneme or uses related	
	practices in				d ner	
	other PCNs				o ta	
Peek	Interrupted	General	Pharmacist-led	The study used an interrupted	The SMASH int 👸 👼 tion was	Strengths: Authors
2020[15]	time series	practice in	Safety	time series analysis of rates	associated with ಕ್ಷ್ಮೀಕ್ಕೆ ಕ್ಲಿಕ್ಕಿ ced rates of	noted pragmatic
		England	Medication	(prevalence) of potentially	potentially hazaျှန်းဝဋိဌာ	design, evaluation of
	43 general		dASHboard	hazardous prescribing and	prescribing and head equate	clinically relevant
	practices		(SMASH).	inadequate blood-test	blood-test mon 📆 📆 🙀 g in general	outcomes and large
	covering		SMASH	monitoring, comparing observed	practices. This addiction was	number of practices
	235,595		involved (1)	rates post-intervention to	sustained over ½ 2 neonths for	taking part
	people in		training of	extrapolations from a 24-month	prescribing but ot or	
	Salford,		clinical	pre-intervention trend. At	monitoring	Limitations: Not a
	Greater		pharmacists to	baseline, 95% of practices had	of medication. 🗖 hei👺 was a	randomised study so
	Manchester		deliver the	rates of potentially hazardous	marked reducti <mark></mark> n i <mark>स</mark> the	possibility of
			intervention;	prescribing (composite of 10	variation in rates of nazardous	unrecognised
			(2) a web-	indicators) between 0.88% and	prescribing <u>a</u> o	confounding cannot
			based	6.19%. The prevalence of	prescribing iii on between practices.	be excluded
			dashboard	potentially hazardous	ne ne	
			providing	prescribing reduced by 27.9%	ine 9, 2025 a echnologies	
			actionable,	(95% CI 20.3% to 36.8%, p <	202	
			patient-level	0.001) at 24 weeks and by 40.7%	lies 5	
			feedback; and	(95% CI 29.1% to 54.2%, p <	, t	
			(3)	0.001) at 12 months after	gen	
			pharmacists	introduction of SMASH. The rate	i c	
			reviewing	of inadequate blood-test	B.	
			individual at-	monitoring (composite of 2		
			risk patients,	indicators) reduced by 22.0%	gra	
		•			9, 2025 at Agence Bibliographique de l nologies.	•

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Rodgers 2022[16] Multiple interrupted time series Midlands region of England covering approximately 3 million patients	and initiating remedial actions or advising GPs on doing so. Pharmacist-led IT intervention to reduce hazardous prescribing (PINCER)	(95% CI 0.2% to 50.7%, <i>p</i> = 0.046) at 24 weeks; the change at 12 months (23.5%) was no longer significant (95% CI –4.5% to 61.6%, <i>p</i> = 0.127). After 12 months, 95% of practices had rates of potentially hazardous prescribing between 0.74% and 3.02%. Successive groups of general practices received the PINCER intervention between September 2015 and April 2017. Eleven prescribing safety indicators were used to identify potentially hazardous prescribing and data were collected over a maximum of 16 quarterly time periods. PINCER was implemented in 370 (94.1%) of 393 general practices; data were successfully extracted from 343 (92.7%) of these practices. For the primary composite outcome, the PINCER intervention was associated with a decrease in the rate of hazardous prescribing of 16.7% (adjusted odds ratio (aOR) 0.83, 95% confidence interval (CI) 0.80 to 0.86) at 6	by copyright, including for uses related to text and 12 months, each of and 12 months intervention. The eductions in handle with a reductions in handle with a reduction of and 12 months, each distinction of GI bleeding. These distinctions in handle with a reduction of PINCER in England.	Strengths: Suggests intervention was implemented successfully in routine practice and was associated with significant reductions in hazardous prescribing Limitations: The authors adjusted for calendar time and practice, but since this was an observational study, the findings may have been influenced by unknown confounding factors or behavioural changes unrelated to

			\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	months and 15.3% (aOR 0.85, 95% CI 0.80 to 0.90) at 12 months post-intervention. The unadjusted rate of hazardous prescribing reduced from 26.4% to 20.1% at 6 months and 19.1% at 12 months. The greatest reduction was for hazardous prescribing indicators related to GI bleeding	-081934 on 7 August 2024. Downlo Enseignement Sup, including for uses related to text;	the PINCER intervention. Data were also not collected for all practices at 6 and 12 months post- intervention
Syafhan 2021[17]	Individual RCT 356 patients at risk of medication-related problems (MRPs) from 8 GP practices	General practice in England (6 practices) and Northern Ireland (2)	Medicines optimisation with shared decision-making and agreed treatment goals. Intervention repeated at 2 and 4 months, building on progress towards agreed goals	Median number of MRPs per intervention patient at 6 months was reduced from 3 to 0.5 (<i>p</i> < 0.001) in patients who received the full intervention schedule. Medication Appropriateness Index (MAI) scores were reduced (medications more appropriate) for the intervention group, but not for control group patients. Using the intention-to-treat (ITT) approach, the number of telephone consultations in intervention group patients was reduced and different from the control group. No significant differences between groups were found in unplanned hospital admissions, length of hospital stay, number of A&E attendances or outpatient visits. The mean overall healthcare	The pharmacistic reduced MRPs, inapproper (ABC) represent the pharmacistic reduced manual properties (ABC) represent the pharmacistic reduced medications and similar technologies. Al training, and similar technologies.	Strengths: Pragmatic randomised design Limitations: Sample smaller than planned; high loss to follow-up; MRP analysis only covered patients who attended 3 appointments

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Thayer 2021[23]	Service evaluation 160 care home residents with intellectual disabilities (ID)	Care homes for people with ID in the Wirral	Pharmacist review of residents' medicines and lifestyle risk factors between November 2019 and May 2020.	cost per intervention patient fell from £1041.7 ± 1446.7 to £859.1 ± 1235.2 (<i>p</i> = 0.032). Cost utility analysis showed an incremental cost per patient of − £229.0 (95% CI − 594.6, 128.2) and a mean QALY gained of 0.024 (95% CI − 0.021 to 0.065),. indicative of a health status gain at a reduced cost (2016/2017). The 160 residents were prescribed 1207 medicines, 74% were prescribed ≥5 medicines and 507 interventions/recommendations were made, averaging 3.3 per resident. The highest proportion (30.4%) were lifestyle risk related, while changing and stopping medicines accounted for 17.9% and 12.8%, respectively. Of the recommendations discussed with GPs/psychiatrists, 86% were accepted.	mjopen-2023-081934 on 7 August 2024. Downloade drings the Enseignement Superieur (ABLES). There was constitutions/remaining, all lifestyle residents and amount medicine accepted by GRIS interventions of william populations with a model could have benefits for residential populations with employees. Wider adoptions with employees accepted by GRIS residential populations with employees and potentially redeem to the residential populations with employees.	Strengths: Drew on skills of pharmacists from different sectors to address wide range of care needs; recommendations addressed national priorities Limitations: Study limited to one CCG area; limited access to patient records; observational study with no control/comparator arm
Twigg 2015[24]	Service evaluation	Community pharmacies in England	Four or More Medicines (FOMM) support	Of 620 patients recruited, 441 (71.1%) completed the 6-month study period. Pharmacists made 142	By focussing on pateents over the age of 65 years with four or more medicines, community pharmacists can improve	Strengths: Large sample of patients and providers; use o

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620 patients		recommendations to prescribers	medicine adherence and patient	validated outcome
(aged over 65	Patients were	in 110 patients, largely centred	quality of life. ding	measures
years and		on potentially inappropriate	n 7 y fo	
prescribed ≥ 4		prescribing of	Au B	Limitations: No
medications)	, , , , , , , , , , , , , , , , , , ,	NSAIDs, PPIs or duplication of	gus ses	control/comparator
		therapy. At follow-up, there was	tt 20 religi	group; authors note
		a significant decrease	n 7 August 2024. I Enseigneme y for uses related t	some patients were
		in the total number of falls	nen:	probably reviewed
		experienced and a significant	t Sun	independently by
		increase in medicine adherence	loa It ar	their GP during the
		and quality of life. Cost per quality-adjusted life	nded ind c	study period; relatively high
		year estimates ranged from£11	fro r (A lata	attrition rate
		885 to £32 466 depending on	BE BE	attrition rate
	-	the assumptions made	nittp nin	
	risk of falls,	the assumptions made.	://bi	
	pain	the assumptions made.	Downloaded from http://bmjopen.bmj.com/ on June 9, 2025 at ent Superieur (ABES) . to text and data mining, Al training, and similar technologies.	
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	were analysed		Aga	
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Appendix Table 2: TIDieR Lite for UK pharmacist studies

Intervention By whom Waname and study ID(s)	What	Where	Intensity Intensity Intensity	How often
independent can be also prescribers (PIPs). The assertion of training programme or prescribers (PIPs) and prescribers (PIPs) are assertion of the prescribers (PIPs). The prescribers (PIPs) are assertion of the prescribers (PIPs). The prescribers (PIPs) are assertion of the prescribers (PIPs) are assertion of the prescribers (PIPs). The prescribers (PIPs) are assertion of the prescribers (PIPs) are assertion of the prescribers (PIPs) are assertion of the prescribers (PIPs).	PIP, in collaboration with the care home resident's GP, assumes responsibility for managing the medicines of the resident, including: • Reviewing resident's medication and developing and implementing a pharmaceutical care plan • Assuming prescribing responsibilities • Supporting systematic ordering, prescribing and administration processes with each care home, GP practice and supplying pharmacy where needed • Providing training in care home and GP practice • Communicating with GP practice, care home,	Participating care homes	PIPs committed a pproximate from http://bmjopen.bmj.com/ on June 9, 2025 at Agence Bibliographique de mental by the provided care and data mining, Al training, and similar technologies. PIPs committed a pproximate a media by the provided care and data mining, Al training, and similar technologies.	PIPs visited care homes weekly over 6 months

		supplying community pharmacy and study team		081934 on 7 including for	
Care home medication reviews Alves 2019[19]	Primary care pharmacists and GPs in Somerset CCG area and CCG staff	Medicines optimisation visits to care homes. Primary care pharmacists visited homes on behalf of GP practices; GPs could participate in visits or hold discussions with pharmacists prior to the visit; screening of safety interventions was done by CCG pharmacist leads	Care homes with and without nursing in Somerset	The time and level of support allocated for the service was a product with the respective CCG Localis Characters. Manager and influence of factors such as engaged by a number of factors such as engaged by a number of factors such as engaged by the prescribing support with a covering the prescribing support with the pr	The aim of the programme was to offer at least one visit to as many care homes as possible (appears to be one visit per year but not explicitly stated)
Shine Medication Optimisation Project Baqir 2017[20]	Pharmacists together with care home nurses and other members of the multi-disciplinary team (MDT), including GPs and mental health professionals as needed. Two different models: pharmacists made prescribing decisions (as part of shared decisionmaking) independently or in conjunction with GPs	A notes based, pharmacist-led review of medicines, where the Northumbria 3Q approach was applied to each medicine, that is, was there an indication, was the indication appropriate and was it safe?. Additionally, medicines missing that could be beneficial (eg, START medicines) were identified. This was followed by a MDT meeting where the information from the pharmacist-led review was discussed and an action plan was formulated. Whenever possible, the final decisions were made with patients and their families. After the review,	Care homes in North East England	Intensity of intervent int	Once, as a funded quality improvement (QI) project

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		the project database was updated to show medicines taken before review, medicines stopped, started or changed and any other interventions made.		bmjopen-2023-081934 on 7 August 20 Enseign by copyright, including for uses rela		
PINCER Howard 2014[11]; Rodgers 2022[16]	Pharmacists specifically trained to deliver the intervention; GPs, other practice staff and pharmacy technicians involved in implementation	Computer systems of general practices are searched to identify patients at risk of potentially hazardous prescribing using a set of prescribing safety indicators. Pharmacists then provide an educational outreach intervention where they meet with GPs and other practice staff to: Discuss the search results and highlight the importance of the hazardous prescribing identified using brief educational materials. These feedback sessions were to be held straight after running the searches and then at regular intervals. Agree on an action plan, retained within the practice, for	General practices	When PINCER was red to the intervitance of the local Medical mining, Al training, and similar technologies. When PINCER was red to the local Medical from http://bmjopen.bmj.com/ on June 9, 2025 at Agence Bibliographique de I de local Medical mining, Al training, and similar technologies. Team Tabout/guidelines xhtml	armacists varied by urcing level	Data collected quarterly up to 12 months after starting the intervention[16]

		reviewing patients identified as high risk and improving prescribing and medication monitoring systems using root cause analysis		-081934 on 7 Augus Ens including for uses	
		Pharmacists (sometimes supported by pharmacy technicians) then work with, and support, general practice staff to implement the agreed action plan, sometimes making the necessary changes themselves		7 August 2024. Downloaded from http://br Enseignement Superieur (ABES) . or uses related to text and data mining, Al	
(electronic composition system (EMOS)) composition available stake (EMOS) doctor pract Jeffries paties	eloped by a private pany (Eclipse tions) and made lable to eholders (including tors, pharmacists, etice managers and ents) by a CCG in South of England	Web-based user interface which securely extracts patient data from general practice patient records. Accessed separately from the GPs' clinical systems, it allows different stakeholders access to real time anonymized patient data including medical histories of diagnoses, prescribed medications and test results. The EMOS is intended to facilitate clinical audits of prescribing activity to identify patients at risk of ADEs, or not appropriately monitored.	General practices covered by the participating CCG	Not reported (qualification) and similar technologies. Not reported (quidelines xhtml	Not reported (qualitative study)

Patients can access the system through a "Patient Passport"							
		Patients can access the system through a "Patient Passport"		31934 or			
Safety Medication dASHboard (SMASH) Jeffries 2018[12]; Peek 2020[15]; Jeffries 2020[26]	Clinical pharmacists working in general practices and other general practice staff	Pharmacists were trained to deliver the intervention and apply root cause analysis techniques to identify, explore, resolve, and prevent medication errors in partnership with general practice staff. Pharmacists and practice staff were given access to a web-based, interactive dashboard that provided feedback on 12 indicators of potentially hazardous prescribing. The dashboard also provided practice-level summary data as well as educational material.	General practices covered by the participating CCG	Practices interacted with the dashboard a median of 12.0 (in representation of 12.0) times per more than the first quarties of use. Over time, dashboard used in the first quarties of the first quart	Dashboard was updated daily. Frequency of use varied by practice and over time (see previous column)		
Structured Medication Review (SMR) Madden 2022[14]; Stewart 2021[27]	Clinical pharmacists within general practice primary care networks (PCNs)	Invited, personalised, holistic review of all medicines and their benefits to health for people at risk of harm or medicine-related problems	General practices	Reviews are recommended to be scheduled for at least 30 minutes to allow time for shared technologies.	Once		
Medicines optimisation intervention	GP practice-based pharmacists operating as part of the wider primary care team	Each pharmacist received 2 days of intensive specialist training	Eight general practices in four regions of the UK	Initial meeting with furt her appointments available of 2 and 4 months building on patient progress towards agreed goals of appointment of the second of the	Once per patient (up to three appointments)		

Syafhan 2021[17]	on medicines optimisation (including training on motivational interviewing). The intervention included: review of patient records prior to meeting; medication history; individual medicines optimisation plan that could include recommending/making changes to medication regimens (in collaboration with GPs), personalised education and counselling on medication management, the correct use of medication management, the correct use of medication administration devices and lifestyle factors; and an agreed list of treatment goals. Pharmacists could also refer patients to another health professional within the practice. Having completed the intervention, the pharmacist produced a short report for the patient's GP outlining actions taken and any further recommendations requiring GP input
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Collaborative pharmacist review Thayer 2021[23]	Community and specialist mental health pharmacists	Medicine review using a structured framework based on recommendations of the 2018 Learning Disability Mortality Review (LeDeR) report. Pharmacists visited care homes to conduct the reviews using individual residents' care home records. The specialist mental health pharmacist also had access to the care record held by the Specialist Mental Health Trust, if the resident was under the Trust's care, and remote access to the local data sharing platform. Assessments included medicines adherence and burden (particularly the anticholinergic burden), respiratory care, vaccination status, constipation risk, sepsis prevention, dysphagia risk and lifestyle risk issues, especially smoking. Finally, pharmacists were asked to detail actions taken/advice provided, any recommendations made and make referrals, as necessary. Following the review, GP surgeries and psychiatrists were contacted by the pharmacists to arrange a review of their	Care homes for people with intellectual disabilities	Once 507 interventions/residents reviewed from http://bm/jopen.bm/.com/ on June 9, 2025 at Agence Bibliographique de le	

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Four or More Medicines (FOMM) support service Twigg 2015[24]	Community pharmacists and pharmacy team members	recommendations. As the pharmacists were not prescribers, decisions on accepting recommendations were made by the resident's GP/psychiatrist (after reviewing the resident's full clinical record) in consultation with the pharmacists Pharmacists were trained via distance learning and face to face, which included how to use the various different tools and assessments. Training was then cascaded to other pharmacy members. Patients were invited to participate in the service by the community pharmacy team. The pharmacist held regular consultations with the patient and discussed risk of falls, pain management, adherence and general health. They also reviewed the patient's medication using STOPP/START criteria.	Participating community pharmacies	at 25 10 25 10 25 10 25 10 25 25 10 25 25 25 10 25 25 25 26 26 26 26 26 26 26 26 26 26 26 26 26	After the first consultation, patients met with the pharmacist on a regular basis depending on when they collected their repeat medication or they felt a need.
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MMAT quality assessment results

Reference	Screening questions	Type of study	MMAT questions and answers
Alharthi	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach app முழாate to answer the research
2023[18]	questions? Yes		question? Yes (identifying perceive ရှိ စို့ကြီriers and facilitators)
			1.2. Are the qualitative data colleத் இmethods adequate to address the
			research question? Can't tell (seco இன்ற analysis of existing data)
	S2. Do the collected data allow		1.3. Are the findings adequately derived from the data? Yes
	to address the research		1.4. Is the interpretation of results iciently substantiated by data? Yes
	questions? Yes		1.5. Is there coherence between ഷ്ലീഷ്ട് Eative data sources, collection,
			analysis and interpretation? Yes (analysis and interpretation? Yes (analysis and interpretation? Yes)
			Framework)
Alves	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes (care
2019[19]	questions? Yes	randomised	home residents)
			3.2. Are measurements appropriate regarding both the outcome and
			intervention (or exposure)? Yes
	S2. Do the collected data allow		3.3. Are there complete outcome at at a Can't tell (partial data presented)
	to address the research		3.4. Are the confounders account d in the design and analysis? No
	questions? Yes		(uncontrolled before/after study)
			3.5. During the study period, is the intervention administered (or exposure
			occurred) as intended? Can't tell (<u>इ</u> de द्विy not monitored)
Baqir	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes (care
2017[20]	questions? Yes	randomised	home residents)
			3.2. Are measurements appropriate regarding both the outcome and
			intervention (or exposure)? Yes o S
	S2. Do the collected data allow		3.3. Are there complete outcome gata? Yes (all specified outcomes
	to address the research		reported)
	questions? Yes		3.4. Are the confounders accounted f in the design and analysis? No
			(uncontrolled before/after study) $\overline{\$}$
			3.5. During the study period, is the in慢rvention administered (or exposure
			occurred) as intended? Can't tell (integentions not externally validated)
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Birt 2021[21]	S1. Are there clear research	Mixed methods	5.1. Is there an adequate rational forgusing a mixed methods design to
	questions? Yes		address the research question? Yes (altalive and quantitative data
			relevant to process evaluation)
			5.2. Are the different components of the study effectively integrated to
	S2. Do the collected data allow		answer the research question? Yeន្តី (អ្វីខ្មែgrated in results and discussion)
	to address the research		5.3. Are the outputs of the integratign of qualitative and quantitative
	questions? Yes		components adequately interpretion (see discussion)
			5.4. Are divergences and inconsist கூடு between quantitative and
			qualitative results adequately add हुई ई d? Yes (page 11 column 2)
			5.5. Do the different components தீத்த் study adhere to the quality
			criteria of each tradition of the met நீன்க involved? Yes
Howard	S1. Are there clear research	Quantitative	4.1. Is the sampling strategy relev क्षार्य कि address the research question?
2014[11]	questions? Yes	descriptive	Yes a A C A C A C A C A C A C A C A C A C A
		\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	4.2. Is the sample representative 🗗 🎢 🚾 target population? Yes (all
			interventions recorded)
	S2. Do the collected data allow		4.3. Are the measurements appropriage? Yes
	to address the research		4.4. Is the risk of nonresponse biaន្លា០ធ្នើ? Yes (data from intervention arm
	questions? Yes		only)
			4.5. Is the statistical analysis appropriate to answer the research
			question? Yes and Dic
Jeffries	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach appropriate to answer the research
2017[13]	questions? Yes		question? Yes (explored factors perceived to affect adoption and
			implementation)
			1.2. Are the qualitative data colleന്പ്രാം adequate to address the
	S2. Do the collected data allow		research question? Yes (interviews and focus groups)
	to address the research		1.3. Are the findings adequately derived from the data? Yes (context-
	questions? Yes		mechanism-outcome groups ident # jed ြို့
			1.4. Is the interpretation of results sufficiently substantiated by data? Yes
			1.5. Is there coherence between qualigative data sources, collection,
			analysis and interpretation? Yes (supported by use of realist analysis)
Jeffries	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach approgriate to answer the research
2018[12]	questions? Yes		question? Yes (explored factors percei
			implementation)

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			1.2. Are the qualitative data collection methods adequate to address the
	S2. Do the collected data allow		research question? Yes (interviews 4 9
	to address the research		1.3. Are the findings adequately derived from the data? Yes
	questions? Yes		1.4. Is the interpretation of results្ទីsu អ្ iciently substantiated by data? Yes
			(supported by relevant quotes) မွို့ ရှိပြု
			1.5. Is there coherence between œ្លាន់ igative data sources, collection,
			analysis and interpretation? Yes (﴿ اللَّهُ اللَّاللَّ الللَّهُ اللَّهُ اللَّهُ الللَّهُ اللَّهُ اللَّهُ اللّل
			Theory) and the control of the cont
Lane	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach appropriate to answer the research
2020[22]	questions? Yes		question? Yes (gather opinions ab கூட்டு oposed service)
		6	1.2. Are the qualitative data colleല്പ് സ്കൂന്റ് methods adequate to address the
			research question? Yes (focus groழு) தீற்ற interviews with different staff
	S2. Do the collected data allow		groups at different sites)
	to address the research	60	1.3. Are the findings adequately dermed from the data? Yes
	questions? Yes		1.4. Is the interpretation of result substantiated by data? Yes
			(supported by relevant quotes)
			1.5. Is there coherence between call ative data sources, collection,
			analysis and interpretation? Yes (ipperted by use of Theoretical Domains
			Framework)
Madden	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach approach approach as answer the research
2022[14]	questions? Yes		question? Yes (pharmacists' experience of SMR implementation)
			1.2. Are the qualitative data collection methods adequate to address the
			research question? Yes (interviews with newly employed and established
	S2. Do the collected data allow		pharmacists)
	to address the research		1.3. Are the findings adequately derived from the data? Yes
	questions? Yes		1.4. Is the interpretation of result substantiated by data? Yes
			(supported by relevant quotes)
			1.5. Is there coherence between qualitative data sources, collection,
			analysis and interpretation? Yes (supperted by thematic analysis)
Peek	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes
2020[15]	questions? Yes	randomised	(general practices and their patients)
			3.2. Are measurements appropriate regarding both the outcome and
			intervention (or exposure)? Can't tell or intervention)
	•	•	
			$oldsymbol{\Omega}$
			<u>দ</u>

S2. Do the collected data allow to address the research questions? Yes Rodgers 2022[16] S3.3. Are there complete outcome and any Yes 3.4. Are the confounders accounted for in the design and a (small risk of unmeasured confounding). S1. Are there clear research questions? Yes C3. Do the collected data allow to address the research questions? Yes S2. Do the collected data allow to address the research questions? Yes S3. Are there complete outcome and their patients appropriate and their patients are propriated and their patients. S2. Do the collected data allow to address the research questions? Yes S3. Are there complete outcome and their patients are propriated and thei		BMJ	J Open Copy
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PRISMA 2020 Checklist

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Section and Topic	Item #	Checklist item	Location where item is reported
TITLE		7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Торонов
Title	1	Identify the report as a systematic review.	Title
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p2
INTRODUCTION		9 0 0	
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction (pp4-5)
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Methods (p6)
METHODS		* 	
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Methods (p6)
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted the date when each source was last searched or consulted.	Methods (p7)
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used	Supplementary file
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation to be only in the process.	Methods (p7)
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each to whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, detage of automation tools used in the process.	Methods (pp7-8)
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which set to collect.	Methods (pp7-8)
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, stinding sources). Describe any assumptions made about any missing or unclear information.	Methods (pp7-8)
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Methods (p8)
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	See methods (p8)
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	See methods (p8)
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	N/A (summary tables only)
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used 2	N/A
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analyses, meta-regression).	Methods (p8)
	13f	Describe any sensitivity arranyses conducted to-dasses / hoobjustness not the stretches ized tresuits lines.xhtml	N/A



PRISMA 2020 Checklist

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Section and Topic	Item #	Checklist item	Location where iten reported
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting aias).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Results (p
RESULTS		e (i 2	
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to t	P10 and Figure 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Suppleme table
Study characteristics	17	Cite each included study and present its characteristics.	Tables 1-4
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Suppleme table
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) and (b) are the stimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Tables 1-4 where available a appropriate
Results of	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Results (p
syntheses	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summare estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Results (p
DISCUSSION		91 2025 99 6	
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Discussio (especiall p27)
	23b	Discuss any limitations of the evidence included in the review.	Discussio (especiall p26)
	23c	Discuss any limitations of the review processes used.	Discussio (pp27-28)
	23d	Discuss implications of the results for practice, policy, and future research.	Discussio (pp28-29)
OTHER INFORMA	TION	<u>Q</u>	
Registration and	24a	Provide registration information for the review only - http://bmiopen.bmi.com/site/about/guidelines.xhtml	Title page



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1 2	PRIS	MA 20	020 Checklist	by copyrigh	36/bmjopen-2023	
3 4 5	Section and Topic	Item #	Checklist item	t, includ	3-08193	Location where item is reported
6	protocol	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	ling	9	Title page
/ Ω		24c	Describe and explain any amendments to information provided at registration or in the protocol.	for	7	P9
9	Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in	žhe,	Eview.	Title page
10 11	Competing interests	26	Declare any competing interests of review authors.	seign s rela	ust 20	Title page
12 13 14	Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection form studies; data used for all analyses; analytic code; any other materials used in the review.	ement S teel to te	ata extracted from included	Data sharing statement (p30)
15 16 17	From: Page MJ, McKe	enzie JE, I	Checklist item Indicate where the review protocol can be accessed, or state that a protocol was not prepared. Describe and explain any amendments to information provided at registration or in the protocol. Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in Declare any competing interests of review authors. Report which of the following are publicly available and where they can be found: template data collection for studies; data used for all analyses; analytic code; any other materials used in the review. Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systems for more information, visit: http://www.prisma-statement.org/	uper∯eur xt an⊠ da	To a control of the c	10.1136/bmj.n71
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