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

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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.

• Many of the studies lacked a control group and the research took place in a highly complex and evolving system, meaning that results could have been influenced by confounding factors such as other interventions in the health and social care system.

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

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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.

Review on the

Methods

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:

- i. 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.

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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:

PROBLEMINTERVENTIONSETTINGOverprescribing;Deprescribing;Primary Care	
Overprescribing; Deprescribing; Primary Care	
Inappropriate prescribing; Structured medication review; (including internation	nal terms
polypharmacy medication reconciliation; for primary care when medicines optimisation; relevant) shared decision making; personalised care	re

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% 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[10].

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.

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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)	Bar Bergers and facilitators to deprescribing Feigner Teigner teigner to to t
Alves 2019[19]	Care home residents	Medication review by primary care pharmacists linked to GP practices	Service evaluation (5 year uncontrolled study)	Ing and the second seco
Baqir 2017[20]	Care home residents	Medication review by pharmacist with or without GP	Retrospective analysis of data from QI programme	Narmer and type of medications stopped
Birt 2021;[21]	Care home residents	Pharmacist independent prescribers responsible for medicines management (CHIPPS)	Mixed methods process evaluation	PH activities, perceived benefits and barriess to implementation
Howard 2014[11]	Pharmacists delivering intervention	IT-enabled pharmacist-led review to reduce medication errors	Cluster RCT (PINCER trial)	Time Faken to complete reviews; recommended interventions and whether 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 mess related to implementation of the incervantion and role of practice pearmacists and others
Jeffries	Stakeholders in general	Electronic medicines optimisation	Qualitative realist	Suggestions to support implementation of
2017[13] Lane 2020[22]	practice and CCG Doctors, pharmacists, care-home managers and	system Pharmacist independent prescriber service	evaluation Qualitative focus groups and interviews	the system Percended benefits of the service and barries and facilitators to implementation

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Madden 2022[14]	Pharmacists working in general practice within PCNs	Structured medication review service within Primary Care Networks	Qualitative interview study	Themes related to early implementation of SNAR Prvice
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	Rates forevalence) of potentially hazardous personal providence of potentially hazardous personal providence blood-test monitoring of a so
Rodgers 2022[16]	General practices in the East Midlands	Pharmacist-led IT intervention (PINCER)	Multiple interrupted time series	। सिंहित्के ors of potentially hazardous
Syafhan 2021[17]	Patients in participating GP practices at risk of MRPs	Pharmacist-supplemented care focusing on medication optimisation	Individual RCT	N 한 관 · · · · · · · · · · · · · · · · · ·
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	Pharmacist inferventions/recommendations and acceptance by GPs and psychiatrists
Twigg 2015[24]	Patients over 65 prescribed four or more medications	Community pharmacist consultation including medication review using STOPP/START rules	Service evaluation	Number of recommendations; falls, medication adherence, quality of life and costs at 6 months
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ble 2: Summ	nary of studies reportin	ng effects of intervent Setting	tions Study design and	م تو ع Outcome measure and effect
\lves !019[19]	Medication review	Care homes	sample size Service evaluation 10,405 patient reviews over 5 years	es regnement 2024. Interventions by pharmacisted to te to to te to to te to to to te to
aqir :017[20]	Medication review	Care homes	Retrospective evaluation of quality improvement project 422 residents in 20 care homes	Number and type of medicate to stopped 19.5% reduction in number de reductions being prescribed relative to baseline
'eek :020[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 vecks and by 40.7% (95% CI 29.1% to 54.2%, $p < 0.001$) at 12 months.
lodgers 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 has and us prescribing The PINCER intervention was associated with a decrease in the rate of hazardous prescribing of 16.2% (adjusted odds ratio (aOR) 0.83, 95% confidence interval (CB0.80 to 0.86) at 6 months and 15.3% (aOR 0.85, 95% CI 0.80 to 0.80 to 0.86) at 5 months post-intervention
yafhan 2021[17]	Pharmacist-led medicines optimisation	General practice	Individual RCT 356 patients at risk of	Medication-related problems (ARP); Medicines Appropriateness Index (MAI) Median number of MRPs per intervention patient at 6 months was

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			(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)		23-081	
			GP practices	appropriate) for the interve	scottes were reduced (ntion group, but not fo	medications more or control group.
Thayer 2021[23]	Review of medicines and lifestyle risk factors	Care homes for adults with intellectual	Service evaluation	Pharmacist interventions/realists	Amendations and a	acceptance by GPs
Twigg 2015[24]	Community pharmacist consultation including medication review	Community pharmacies	Service evaluation 620 patients (aged over 65 years and prescribed ≥ 4 medications	Number of recommendation of life and costs at 6 month	tention ac tention ac tention to the second tention to the second tention	lherence, quality
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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% Cl 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-

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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[39].

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 s achieve. interventions and outcomes achieved in routine practice

Reference Alves 2016[28]	Population	Intervention		
Alves 2016[28]			Study design	Outcome measures and key findings
2016[28]	Care nome residents	Medication review by	Service evaluation	Interventions by blog macist; barriers and facilitators
		primary care pharmacists	(retrospective	A total of 2916 interventions were made in 1047 patients
		linked to GP practices	analysis and	of which depresented 22%
Bryant	Primary care	Polypharmacy clinics in GP	Service evaluation	Beductions in presentations: cost savings: hospital
2019[31]	natients taking ten	surgeries	(retrospective data	admissions avoider 8
2019[31]	or more medications	Surgeries	analysis)	April 2017 to Mage 2018, 370 patients reviewed and
				£50.766.63 save 2 1 gares for April to December 2018
				were 209 and £1, 54, respectively
Chauhan	Patients recently	Post-discharge medication	Formative service	Medication changes for the second sec
2022[35]	discharged from	review by clinical pharmacist	evaluation	16/35 patients hed nedications changed; 74% (25/34) of
	hospital	linked to GP practice	(uncontrolled)	changes were medications stopped
Din 2020[32]	Patients referred by	Polypharmacy review clinics	Service evaluation	Changes to medigation, feedback from patients and MDT
	GPs	led by pharmacist	(uncontrolled)	Pharmacist medication reviews were effective, with
		independent prescriber with		positive feedback received from patients and members o
		shared decision-making		the MDT. Depreseribing and inhaler counselling were the
				most common interventions.
Din 2022[34]	Primary care	Frailty review involving	Comparative cohort	Changes in medietion (including cholinergic burden),
	patients living with	pharmacist as part of MDT		practice contact and falls
	frailty			Intervention grogo had a reduction in total number of
				medications when compared with non-intervention
				cohort. Anti-cholineၾခဲ့ic burden scores were reduced by a
				mean of 26%
	frailty			medications when compared with non-initiation of 26%

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vherty Care home re 20a[36], 20b[37]	esidents Medicines Optimisation in Older People (MOOP) involving case management by pharmacists	Uncontrolled before/after	Finappropriate prescripting; unplanned hospital admissions, GP visits; clinical fitte ventions Inappropriate prescripting was highly prevalent at baseline (84.1%) but improver significantly from baseline (M = 14.87, SD = 13.1 fg from obseline (M = 2.04, Z = 25.97, pr≪4001).
nyai Patients ageo 17[33] least 75 year prescribed 15 more medica	l at Pharmacist-led polypharmac s and review clinic in primary care tion	zy Survey	Patient satisfaction Of the 166 patient who returned a satisfaction questionnaire (40%) sponse rate), 83% found the service helpful, 13% did hef, 2% did not know and 2% did not respond
lovetsios Care home re 18[39] needing palli care	esidents Structured medication reviews carried out in agreement with patient, nurse, family/carer and GP	Service evaluation	Changes to mediation, estimated cost savings From January 20 reviews took place for sulting in 1787 suggested medication changes. Approximately 76% of these changes were agreed and actioned by patients' GPs, with estimated saving of 169,986.96.
/ift Care home re 18[38]	esidents 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 recommendation mg de to prescribers, 85% were accepted and resulted in a reduction in inappropriate polypharmacy
afhan Patients in 19[30] participating practices at r MRPs	Pharmacist-supplemented GP care focusing on medication isk of optimisation	Individual RCT	Number of mediation related problems (MRPs) and medication inappropriateness A total of 356 adult patients (175 control and 181 intervention) were recruited. Among 108 intervention patients who had the pharmacist face-to- face contacts, 346 MRPs were identified at baseline and 83 MRPs at 6

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Fable 4: Summar	y of selected grey literature	case studies	-081934 on 7 , including f
Setting	Name of initiative	Key findings	Comments.5
Brighton and	An evaluation of a clinical	A total of 1,300 patients were referred into the service	The targed batient cohort of frail or older
Hove CCG	pharmacist medication	and reviewed between April 2017 and March 2018; 9%	person
	review service in primary	of patients were deprescribed high-risk medicines	from searches within GP clinical systems and
	care		through states from clinical practitioners,
			voluntady and social care services
Swale CCG	Medicines Optimisation	In 2018/19, pharmacists and pharmacy technicians	Targeta
	Review Programme	reviewed 5281 patients and made 3859 interventions,	Key fea
		37% for adverse drug reactions (ADRs). Estimated in-	cases dat fro
		year cost savings were £239,546	
NE Hampshire	Care homes pharmacist	Pharmacist accompanying GPs visiting care homes	Limited
and Farnham		carried out over 250 medication reviews and 800	
CCG		interventions. Average number of medicines per	
		resident fell from 9.4 to 7.6	
NE Hampshire	Polypharmacy	Tool developed by Wessex AHSN was used to identify	Limited at reported
and Farnham	prescribing comparators	patients at risk of harm, resulting in significant	ar jo
CCG		reductions in percentage of patients aged over 75	l om
		prescribed 15 or more medications and percentage with	simi or
		an anticholinergic burden score of 6 or more	
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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].

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.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 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

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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://pharmaceuticaljournal.com/article/news/nhs-england-removes-financial-incentives-for-structured-medicationreviews-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.

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Conflict of interest

The authors have no conflicts of interest to declare.

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

Stu	ıdy ID	Study design/sample size	Setting	Intervention	Key findings	Authors' conclet by an ended	Study strengths/limitations
Alf 20	narthi 23[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'	PiPs' involvement increases is influenced by Marerous barriers and entry for the state can be addressed to improve intervention effectiveness and similar 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
					records, deprescribing decision support, regular follow-up from care home staff, resident	Bibliographiqu	rather than exclusively on deprescribing

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				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.	81934 on 7 August 2024. Down Enseignement S ncluding for uses related to te	
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 reversion and monitoring of reedinines and offers potentiae drug 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 or care home residents through at deprescribing access. Patients' medicine regingens vere simplified and optimised while making financial samings for the NHS	Strengths: Compares two approaches to delivering medication review Limitations: Short- term uncontrolled study; intervention quality/fidelity not measured

Birt N 2021[21] n e c	Mixed methods process evaluation of	Care homes in England,	Integration of	Were estimated at £65,471	in o	
	methods process evaluation of	in England,	integration of		The intervention was generally	Strongthey Invol
a 2 h a r G p lu F (c c	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	Scotland and Northern Ireland	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 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 besidest stakeholders. The second Whilst there were an entitiest effected PIP energy most effective when a common second pathways between TIP and GP had been previously establing. Al training, and similar technologies. Al training, and similar technologies.	three UK nation differing healthd systems; used s records to supplement qualitative data Limitations: Inte participants ma be representativ limited access to home residents

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Howard 2014[11]	Process evaluation of data from cluster RCT 36 intervention and 36 control practices; 1946 patients identified as at risk in intervention practices	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 also reviewed	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.	Recommendations & You the pharmacists were by oadly acceptable to Gos and led to ameliorative action in the majority of cases and and similar technologies. Bibliogra Biblio	Strengths: Uses data from a large cluster RCT Limitations: Pharmacists did not record detailed reasons for their judgements and these were not peer reviewed

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			cases of potentially hazardous medication and recommended interventions to GPs		1934 on 7 August 2024. Do Enseignemer ncluding for uses related t	
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 error of the system is owned control of the potential stake of an ADE. To for the potential benefits of an ADE. To for the potential benefits of an ADE. To for the potential benefits of the potential benefits of the potential benefits of the potential benefits of the potential stake bolders and with a wider range of stakeholders. Engaging with all potential stake bolders and users prior to implementation might allay perceptions that the system is owned centrally and increase knowledge 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	43 general practices in Salford, Greater Manchester	Electronic audit and feedback surveillance dashboard to identify patients	Engagement with the dashboard involved a process of 'sense- making' by pharmacists. The intervention helped to build respect, improve trust and develop relationships between pharmacists and GPs.	Medicine optine sation in primary care may be enhanced by the implementation of a pharmacist-led electronic audit and feedback system. This intervention estable hed a rapid learning health system that	Strengths: Use of Normalization Process Theory as a framework to understand implementation

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	GPs, 12 pharmacists, 7 other GP staff)		risk of hazardous prescribing or monitoring of medicines	communication between pharmacists and clinicians was primarily initiated by pharmacists and was important for establishing the intervention.	in ealth records to be used to make changes in procession of the second	Limitations: Evaluation team also developed the intervention; number of follow-up 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 team- working 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 care- home staff; and dialogue about developing the service with residents and relatives	The overarching the provide the providet the provid	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	General practice in England	Structured medication review (SMR) for people at risk of harm or	SMR implementation was largely delegated to individual pharmacists. Established pharmacists appeared more ready for implementation than	Early implementation of SMRs did not match the intention of providing patients with a holistic review and shared decision- making. The author intention	Strengths: based on detailed, in-depth interviews

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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 oppo of SMR implementation adequate skills development, tess related to text and data min	Limitations: Au note interview to be complen by data on act practice and lo 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%, <i>p</i> < 0.001) at 24 weeks and by 40.7% (95% CI 29.1% to 54.2%, <i>p</i> <	The SMASH intervention was associated with reduced rates of potentially hazardous prescribing and nasequate blood-test more toring in general practices. This eduction was sustained over a 2 months for prescribing but not for monitoring of medication. There was a marked reduction in rates of nazardous prescribing is between practices. Of nazardous	Strengths: Aut noted pragma design, evalua clinically relev outcomes and number of pra taking part Limitations: No randomised st possibility of unrecognised confounding c 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	(3) pharmacists reviewing individual at- risk 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% Cl 0.2% to 50.7%, $p =$ 0.046) at 24 weeks; the change at 12 months (23.5%) was no longer significant (95% Cl –4.5% to 61.6%, $p = 0.127$). 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	The PINCER intervention. The protection is associated with a reduction in hazardous prescribing by \$7% and 15% at 6 and 12 months bosb intervention. The greatest reductions in hazardous prescribing were fob indicators associated with a resolution. The greatest reductions in hazardous prescribing were fob indicators associated with a resolution. The greatest reductions in hazardous prescribing were fob indicators associated with a resolution. The greatest reductions in hazardous prescribing were fob indicators associated with a resolution. The greatest reductions in hazardous prescribing were fob indicators associated with a resolution. The greatest reductions in hazardous prescribing were fob indicators associated with a resolution. The greatest reductions in hazardous prescribing were fob indicators associated with a resolution. The greatest reduction is in a stardous prescribing were fob indicators associated with a resolution. The greatest reduction is in a stardow indicator for the wider nation and the stardow is the star	Strengths: Suggests intervention was implemented successfully in routine practice and was associated with significant reduction in hazardous prescribing Limitations: The authors adjusted for calendar time and practice, but since this was an observational study, the findings may

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Syafhan 2021[17]Individual RCT356 patients at risk of medication- 	General practice in England (6 practices) and Northern Ireland (2)Me opt ded agrIreland (2)tre goa Intu rep and bui pro tov agr	edicines otimisation th shared ecision- aking and reed eatment als. tervention peated at 2 ad 4 months, ailding on ogress wards reed goals	16.7% (adjusted odds ratio (aOR) 0.83, 95% confidence interval (Cl) 0.80 to 0.86) at 6 months and 15.3% (aOR 0.85, 95% Cl 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 Gl 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	-081934 on 7 August 2024. Downloaded from Enseignement Superieur (AB Sice reduced MRPs, inapproxidate phone consultations and temperal practice in a cost-effections in the manner general practice in a cost-effection of the manner	have been influ by unknown confounding fa or behavioural changes unrela the PINCER intervention. D were also not collected for al practices at 6 a months post- intervention Strengths: Prag randomised de Limitations: Sa smaller than planned; high I follow-up; MRF analysis only co patients who attended 3 appointments

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hospital stay, number of A&E attendances or outpatient visits. The mean overall healthcare cost per intervention patient fell	3-08193/ ht, incluc	
Thayer Service Care homes Pharmacist reduced cost (2016/2017). Thayer Service Care homes Pharmacist review of 2021[23] evaluation for people with ID in review of residents were 160 care home the Wirral medicines and lifestyle interventions/recommendations interventions/recommendations intellectual disabilities (ID) November 2019 and May 2020. ifestyle risk related, while recommendations discussed with GPs/psychiatrists, 86% were accepted. for geople with GPs/psychiatrists, 86% were accepted.	There was considered to text and data mining for uses related to text and data mining level of pharmacists' mining level of pharmacists' mining level of pharmacists' mining and lifestyle risk, most of which were accepted by GPP/pSpchiatrists. Wider adoption of collaborative pharmacist reverse models could have benefits for residential populations wigh ID2 and potentially reduce the services of t	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

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Twigg 2015[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	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 orthogen by four or the age of 65 years with four or more medicines community pharmacists care integer and patient guality of life. The second on June 12, 2025 at Agence E units of the second of the	Strengths: Larg sample of patie and providers; validated outco measures Limitations: No control/compa group; authors some patients v probably review independently their GP during study period; relatively high attrition rate
			were analysed		siblio	

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Appendix Tab	le 2: TIDieR Lite for U	for the first 6 months of participation in the service.		081934 on 7 August 2024. Do Enseignemen including for uses related to	
Intervention name and study ID(s)	By whom	What	Where	Intensity dated 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 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 	Participating care homes	PIPs committed a man minimum of 16 hours/month to del man minimum of 16 hours/month to del man be service. Each PIP provided care to approximate 20 residents and similar technologies. Bit	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 		t, including for uses related to text a	-081934 on 7 August 2024. Downloa	
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 signature for the service was signature respective CCG Location Manager and influe factors such as engagem practices; primary care availability; skills and co number of care hone par registered with each GP geographic area covered prescribing support sha	port allocated d with the harmacist by a number of ent from GP harmacists' fidence; tients practice; and by the macists	The aim of the programme wa offer at least o visit to as man care homes as possible (appe to be one visit year but not explicitly state
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 Prescribing decision pharmacists alone of in with GPs	anot reported. End be made by Conjunction	Once, as a fund quality improvement project

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	shared decision- making) independently or in conjunction with GPs	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, the project database was updated to show medicines taken before review, medicines stopped, started or changed and any other interventions made.		1934 on 7 August 2024. Downloaded from htt Enseignement Superieur (ABES ncluding for uses related to text and data min	
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	General practices	When PINCER was rollectout in the East Midlands, time spent by baharmacists delivering the intervantion varied by CCG depending on the resourcing level of the local Medicines Optimisation Team	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 	91/0	31934 on 7 August 2024. Downloaded from http://bmjopen.bmj.com/ on June 1 Enseignement Superieur (ABES) . ncluding for uses related to text and data mining, AI training, and similar tech	
Eclipse Live Developed (electronic company (medicines Solutions) optimisation available t system stakeholde (EMOS)) doctors, pl practice m	l by a private Eclipse and made o ers (including harmacists, anagers 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	Not reported (quality 025 at Agence Bibliog	Not reported (qualitative study

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Jeffries patients) 2017[13] the South	by a CCG in p of England h p re to p a P th	atient data including medical istories of diagnoses, rescribed medications and test esults. The EMOS is intended o facilitate clinical audits of rescribing activity to identify atients at risk of ADEs, or not ppropriately monitored. atients can access the system hrough a "Patient Passport"		1934 on 7 August 2024. Downloa Enseignement Supe cluding for uses related to text a	
Safety Clinical ph Medication working ir dASHboard practices a (SMASH) general pr Jeffries 2018[12]; Peek 2020[15]; Jeffries 2020[26]	narmacists P n general d and other a ractice staff te m p p to d fe p p su e	harmacists were trained to eliver the intervention and pply root cause analysis echniques to identify, explore, esolve, and prevent nedication errors in artnership with general ractice staff. Pharmacists and ractice staff were given access o a web-based, interactive ashboard that provided eedback on 12 indicators of otentially hazardous rescribing. The dashboard also rovided practice-level ummary data as well as ducational material.	General practices covered by the participating CCG	Practices interacted with the dashboard a median of 12.0 (in a first range, 5.0–15.2) times per month during the first quarter of use. Over time, dashboard use transitioned towards regular but tess requent (median of 5.5 [3.5–4.9] times per month) checks to identity and resolve new cases. The frequency of dashboard use was higher in practices with a larger number of at-risk patients.	Dashboard was updated daily. Frequency of use varied by practice and over time (see previous column)
Structured Clinical ph Medication within ger Review (SMR) primary ca (PCNs)	harmacists Ir heral practice re are networks th p o	nvited, personalised, holistic eview of all medicines and heir benefits to health for eople at risk of harm r medicine-related problems	General practices	Reviews are recommen ded to be scheduled for at least 30 minutes to allow time for shared degision-making	Once

Page 55 of 88 1 2			BM	J Open	mjopen-2023-08 by copyright, ir	
3 4 5 6 7	Madden 2022[14]; Stewart 2021[27]				1934 on 7 Aug cluding for us	
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 31 32 33 34 35 36 37 38 39	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 rule appointments available interest 2 and 4 months building on state of the second on June 12, 2025 at Agence Bibliog towards agreed goat text and data mining, Al training, and similar technologies.	Once per patient (up to three appointments)

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		produced a short report for the patient's GP outlining actions taken and any further recommendations requiring GP input		1934 on 7 August Ens cluding 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/readents reviewed from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliogra resident) to text and data mining, AI training, and similar technologies.	ofor Once

				023-08 [,] ight, in	
Four or More Medicines (FOMM) support service Twigg 2015[24]	Community pharmacists and pharmacy team members	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 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.	Participating community pharmacies	Pharmacist time est for uses related to text and data mining, Pharmacist time est for initial consultation, 10 minutes for quarter for quarter bill Pharmacist time est for monthly greene Bill Pharmacist time est for monthly greene Bill Pharmacist time est for monthly greene Bill Pharmacist time est for monthly greene Bill Pharmacist time est for monthly for quarter for quarter for quarter for quarter for quarter for monthly for quarter for quarte	After the first consultation, patients met with the pharmacist or regular basis depending on when they collected thei repeat medica or they felt a

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2 3 4 5 6		patient's medication using STOPP/START criteria.			081934 on 7	
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43		For peer review only - http://bmjop	ben.bmj.com/site/	about/guidelines.xhtml	7 August 2024. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique de I Enseignement Superieur (ABES)	
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Full paper excludes with reasons for exclusion

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APA PsycInfo <1806 to January Week 5 2023>

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11 12 13 14 15 16			Limiters - Published Date: 20130101-20231231 Expanders - Apply equivalent da	Interface - EBSCOhost Research Databases Search Screen -	
17 18	S16	S6 AND S10 AND S14	subjects ឆឺ (A Search modes - Boolean/Ph ម្នាស់	Advanced Search Database - CINAHL	307
19 20 21	S15	S6 AND S10 AND S14	ng, Al	p://bmi	327
21 22 23	S14	S11 OR S12 OR S13	trainin	open.	13,914
24 25	S13	(intervention* or initiative* or campaign*) n3 pharmacist*	g, and		1,981
26 27 28 29		"structured medication review" or "medication reconciliation" or "medicine* optimi#ation" or "shared decision making" or "personalised care" or "personalized	similar tech	n/ on June 1	
30 31 32	S12	care"	nologi	2. 202	10,941
33 34	S11	deprescri* or de-prescri*	ů S	5 at Ac	1,345
35 36	S10	S7 OR S8 OR S9		Sence	336,381
37 38 39 40	S9	("primary care" or "primary health care" or "primary healthcare" or "primary medical care") OR (GP or "general	-	Bibliograp	333,015
41 42 43 44 45 46		For peer review only - http://bmjopen.bmj.	com/site/about/guidelines.xhtml	nique de l	

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1 2		71 2023-08 right, ir	
3 4 5 6 7		practi*" or "family practi*" or "family physician*" or "community pharmac*" or dental or dentist* or optometrist* or optician*)	
8 9	S8	(MH "Family Practice")	26,910
10 11 12	S7	(MH "Primary Health Care") OR (MH "Physicians, Family")	90,488
13 14	S6	S1 OR S2 OR S3 OR S4 OR S5	12,727
15 16	S5	polypharmacy or poly-pharmacy	7,664
17 18 10		(MH "Polypharmacy (Saba CCC)") OR (MH	
20	S4	"Polypharmacy+")	5,635
21 22	S3	overprescri* or "over prescri*"	1,026
23 24		(hazardous* or excessive* or inappropriate* or unnecessar*	
25 26	S2	or nonessential or non-essential or inessential) n3 prescri*	4,996
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42	S1	(MH "Inappropriate Prescribing") milar technologies. Bibliographique	3,448
43 44 45		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml	

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Date R	Sun: 08/02/2023 13:50:34
Comm	ent:
ID	Search Hits
#1	MeSH descriptor: [Inappropriate Prescribing] explode all trees 234
#2	MeSH descriptor: [Polypharmacy] explode all trees 312
#3 essenti	((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or "non ial" 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 pharma	(GP or "general practi*" or "family practice" or "family physician*" or "community ac*" 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 "share	("structured medication review" or "medication reconciliation" or "medicine* optimi*" o d 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

MMAT quality assessment results

3 4

MMAT quali	ity assessment results	BMJ	J Open J by copyright, including for
Reference	Screening questions	Type of study	MMAT questions and answers
Alharthi	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach appropriate to answer the research
2023[18]	auestions? Yes	Quantative	auestion? Yes (identifying perceiver and facilitators)
			1.2. Are the qualitative data collection methods adequate to address the
			research question? Can't tell (secon \vec{p}_{a} 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 result substantiated by data? Yes
	questions? Yes		1.5. Is there coherence between ထိုဆို၊မို့ative data sources, collection,
			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 dat and <i>Can't tell (partial data presented)</i>
	to address the research		3.4. Are the confounders accounted for 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 (#delety 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
	52. Do the collected data allow		Are there complete outcome detail Vec (all specified outcomes
	sz. Do the collected data allow		s.s. Are there complete outcome datar res (un specified outcomes
	questions? Ves		$\underline{\mathbf{g}}_{\underline{\mathbf{g}}}$
	questions: 703		(uncontrolled before/after study)
			3.5. During the study period, is the intervention administered (or exposure
			occurred) as intended? Can't tell (inte ^{ff} ventions not externally validated)
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				right, in
[Birt 2021[21]	S1. Are there clear research	Mixed methods	5.1. Is there an adequate rational for dusing a mixed methods design to
		questions? Yes		address the research question? Yes (q_{b}) alitative and quantitative data
				relevant to process evaluation) $\frac{2}{5}$
				5.2. Are the different components of the study effectively integrated to
		S2. Do the collected data allow		answer the research question? Yes (a grated in results and discussion)
		to address the research		5.3. Are the outputs of the integration of qualitative and quantitative
		questions? Yes		components adequately interpret
				5.4. Are divergences and inconsist and between quantitative and
				qualitative results adequately addres المراجع addres adequately addres adequately addres are (page 11 column 2)
				5.5. Do the different components 🎽 🛱 👼 study adhere to the quality
				criteria of each tradition of the met සිංද්ලී involved? Yes
	Howard	S1. Are there clear research	Quantitative	4.1. Is the sampling strategy relevant to address the research question?
	2014[11]	questions? Yes	descriptive	Yes
				4.2. Is the sample representative 聲節聲 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 bias low? Yes (data from intervention arn
		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 approa
	2017[13]	questions? Yes		question? Yes (explored factors pereceiged to affect adoption and
				implementation)
				1.2. Are the qualitative data collegionemethods adequate to address th
		S2. Do the collected data allow		research question? Yes (interview 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
				1.4. Is the interpretation of results sufficiently substantiated by data?
				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 appropriate to answer the research
	2018[12]	questions? Yes		question? Yes (explored factors perceized to affect adoption and
1				implementation)

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	S2. Do the collected data allow to address the research questions? <i>Yes</i>		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 Process Theorem
Lane 2020[22]	S1. Are there clear research questions? Yes	Qualitative	1.1. Is the qualitative approach and a conswer the research approach approa
	S2. Do the collected data allow to address the research questions? Yes	664	groups at different sites) i i i i i i i i i i i i i i i i i i i
Madden 2022[14]	S1. Are there clear research questions? <i>Yes</i> S2. Do the collected data allow to address the research questions? <i>Yes</i>	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,
Peek 2020[15]	S1. Are there clear research questions? Yes	Quantitative non- randomised	analysis and interpretation? Yes (supported by thematic analysis) 3.1. Are the participants representative of the target population? Yes (general practices and their patients) general practices and their patients general patients general patients general patients general patients <tr< td=""></tr<>

			oen-2023-0
	S2. Do the collected data allow		3.3. Are there complete outcome atag Yes
	to address the research		3.4. Are the confounders account झूँव for in the design and analysis? No
	questions? Yes		(small risk of unmeasured confounding)
			3.5. During the study period, is the intervention administered (or exp
			occurred) as intended? Can't tell () Representations 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 patients is a
			3.2. Are measurements appropriate are garding both the outcome and
			intervention (or exposure)? Can't ferr for intervention)
	S2. Do the collected data allow		3.3. Are there complete outcome again No (6- and 12-month data not
	to address the research	6	collected from all practices) $\vec{a} = \vec{b} \vec{a}$
	questions	No	s.4. Are the comounders accounted on the design and analysis? No
			3.5 During the study period is the intervention administered (or exp
			occurred) as intended? Can't tell (The wentions not externally validated
Svafhan	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)
[-/]	4	trial	2.2. Are the groups comparable a baseline? 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? Car
	questions? Yes		tell (outcome data from GP electro
			2.5 Did the participants adhere to the assigned intervention? No (30%
			to follow-up or withdrew) 🗸 🖉 🖉
Thayer	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes
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
	52. Do the collected data allow		associated outcomes)
	to address the research		5.3. Are there complete outcome data? Yes (all specified outcomes
	questions? res		2.4 Are the confounders accounted for in the design and analysis? M
			(uncontrolled before /after study)

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			3.5. During the study period, is th∉ int@rvention administered (or exposure
			occurred) as intended? Yes (one-oத rebiew 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 \mathbf{k} presentative sample)
			3.2. Are measurements appropria 🖉 🖉 arding both the outcome and
			intervention (or exposure)? Yes (de the recorded for intervention
	S2. Do the collected data allow		components and associated outcoឱ្យឝ្វីឝ្ទីន្ត្រី
	to address the research		3.3. Are there complete outcome द्विन्द्वे के Can't tell (limited response for
	questions? Yes		resource use outcomes)
			3.4. Are the confounders account දිස් දිකු in the design and analysis? No
		6	(uncontrolled before/after study) គ្នី គ្លី ថ្ល
			3.5. During the study period, is the fit forvention administered (or exposure
			occurred) as intended? Can't tell (ម្មីហ្វាង្ហិច័្យx. 30% withdrawal rate)
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1 2	PRISM	MA 2(D20 Checklist	
3 4 5	Section and Topic	ltem #	Checklist item	Location where item is reported
6	TITLE	I		
7	Title	1	Identify the report as a systematic review.	Title
8	ABSTRACT			
9	Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p2
10	INTRODUCTION	1		
12 13	Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction (pp4-5)
14	Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Methods (p6)
15	METHODS	1		
16	Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Methods (p6)
17 18	Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to the date when each source was last searched or consulted.	Methods (p7)
19 20	Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used	Supplementary file
21 22 23	Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many regiewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation to be a screened in the process.	Methods (p7)
23 24 25 26	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)
20 27 28	Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which gesuits to collect.	Methods (pp7- 8)
29 30		10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, and g sources). Describe any assumptions made about any missing or unclear information.	Methods (pp7- 8)
31 32	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, here were assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Methods (p8)
33 34	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)
35 36	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)
37 38		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
39 40		13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	N/A (summary tables only)
41 42		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 a	N/A
43 ⊿л		13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analy as meta-regression).	Methods (p8)
44 45		13f	Describe any sensitivity analyzes conducted to assess projutions with ested tress with slines. with the state of the state	N/A
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PRISMA 2020 Checklist

		BMJ Open BMJ Open by jo	Page 88 of 8
PRIS	MA 20	020 Checklist	
Section and Topic	ltem #	Checklist item	Location where item is reported
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
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Results (p8)
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the process included in the review, ideally using a flow diagram.	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.	Supplementary 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.	Supplementary table
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) are the stimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Tables 1-4 where available and appropriate
Results of	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Results (p22)
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 gire ation 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 as ed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Results (p22)
DISCUSSION		9 20 2 9 2	
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Discussion (especially p27)
	23b	Discuss any limitations of the evidence included in the review.	Discussion (especially 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	Por peer review only - http://bm/open.bm/.com/site/apout/guidelines.xntmi.	Title page

PRISMA 2020 Checklist

Pa	ge 89 of 88		BMJ Open	cted I	36/bm	
1 2	PRI	SMA 20	020 Checklist	oy copyrigh	njopen-2023	
3 4 5	Section and Topic	ltem #	Checklist item	t, incluc	-081934	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	on	Title page
7		24c	Describe and explain any amendments to information provided at registration or in the protocol.	for	7 4 7	P9
o 9	Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or spons	ors in ភ្ន៍ he	geview.	Title page
10 11	Competing interests	26	Declare any competing interests of review authors.	nseign es rela	ust 200	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 studies; data used for all analyses; analytic code; any other materials used in the review.	n formation to to to to to to	ata extracted from included	Data sharing statement (p30)
16 17 18 19 20 21 22 23 24 25 26 27 28	From: Page MJ, Mcł	Kenzie JE, F	Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting For more information, visit: <u>http://www.prisma-statement.org/</u>	er验ur (ABES). ar罶 data mining, Al training, and sin ^{syster}	die views. BMJ 2021;372:n71. doi: from http://bmjopen.bmj.com/	10.1136/bmj.n71
20 29 30 31 32 33				nilar technologie	on June 12, 2025	
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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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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

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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.

- Many of the studies lacked a control group and the research took place in a highly complex and evolving system, meaning that results could have been influenced by confounding factors such as other interventions in the health and social care system.
- Some review processes were performed by a single reviewer and meta-analysis was not feasible.

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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. 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

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:

- i. 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.

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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;	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[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. 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[10].

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.

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Population	Intervention	Study design	යි ප ට 7 Ogtrogine measures
e controlled studies Pharmacists delivering intervention	IT-enabled pharmacist-led review to reduce medication errors	Cluster RCT (PINCER trial)	នូ ភ្លូ ភ្លូ ភ្លូ Tថ្មីទៀង Ken to complete reviews; rថ្មីទៀវភាគended interventions and whethe
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	Reference of potentially hazard prevalence) of potentially hazard prevalence of potential hazard potential hazard prevalence of potential hazard potential hazard prevalence of potential hazard potential hazard potential hazard potential hazard pote
General practices in the East Midlands	Pharmacist-led IT intervention (PINCER)	Multiple interrupted time series	In the fors of potentially hazardous
Patients in participating GP practices at risk of MRPs	Pharmacist-supplemented care focusing on medication optimisation	Individual RCT	Normalizer of medication related problems (Normalizer of medication inappropriatene
e uncontrolled studies		81.	
Care home residents	Medication review by primary care pharmacists linked to GP practices	Service evaluation (5 year uncontrolled study)	Interventions by pharmacist (including depresentions and changes to personal presentions)
Care home residents	Medication review by pharmacist with or without GP	Retrospective analysis of data from QI programme	Net mb r and type of medications stoppe
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	PFarmacist interventions/recommendations and acceptance by GPs and psychiatrists
	 Population controlled studies Pharmacists delivering intervention 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 cuncontrolled studies Care home residents Care home residents with intellectual disabilities 	BMJ Open mary of research study characteristics Population Intervention controlled studies Pharmacists delivering intervention IT-enabled pharmacist-led review to reduce medication errors General practice patients with one or more risk factors for hazardous prescribing or inadequate blood test monitoring Pharmacist-led Safety Medication dASHboard (SMASH) intervention General practices in the East Midlands Pharmacist-led IT intervention (PINCER) Patients in participating GP practices at risk of MRPs Pharmacist-supplemented care focusing on medication optimisation cuncontrolled studies Medication review by primary care pharmacists linked to GP practices Care home residents Medication review by pharmacist with or without GP 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	BMJ Open Population Intervention Study design controlled studies Pharmacist delivering intervention IT-enabled pharmacist-led review to reduce medication errors Cluster RCT (PINCER trial) 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 General practices in the East Midlands Pharmacist-led IT intervention (PINCER) Multiple interrupted time series Multiple interrupted time series Patients in participating GP practices at risk of MRPs Pharmacist-supplemented care focusing on medication optimisation Individual RCT Care home residents Medication review by primary care pharmacists linked to GP practices duals with or without GP Service evaluation (5 year uncontrolled studies community pharmacists and a specialist mental health pharmacist providing review of medicines and lifestyle risk factors Service evaluation

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Twigg	Patients over 65	Community pharmacist consultation	Service evaluation	Nember of recommendations; falls,	
2013[24]	medications	STOPP/START rules		Costs at 6 months	
Qualitative,	mixed methods	· ·			
Alharthi 2023[18]	Care home residents	Deprescribing by pharmacist independent prescriber	Qualitative interviews with participants in a cluster RCT (CHIPPS study)	Base eigness related to to te	
Birt 2021;[21]	Care home residents	Pharmacist independent prescribers responsible for medicines management (CHIPPS)	Mixed methods process evaluation	Pr Sourceived benefits and bar and ban	
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 Best related to implementation of the intermediate and role of practice pearmacists and others	
Jeffries 2017[13]	Stakeholders in general practice and CCG	Electronic medicines optimisation	Qualitative realist evaluation	Saggetions to support implementation of the system	
Lane 2020[22]	Doctors, pharmacists, care-home managers and staff, residents and relatives	Pharmacist independent prescriber service	Qualitative focus groups and interviews	Perceived benefits of the service and barries and facilitators to implementation	
Madden 2022[14]	Pharmacists working in general practice within PCNs	Structured medication review (SMR) service within Primary Care Networks	Qualitative interview study	The mess related to early implementation of Son R Service	

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ible 2: Summ	nary of studies reportion	ng effects of interven	tions Study design and	Outcome measure and effect.stree
			sample size	es
Alves 2019[19]	Medication review	Care homes	Service evaluation 10,405 patient reviews over 5 years	Interventions by pharmacise 2024. ted to to te solutions by pharmacise 2024. to to te solutions by pharmacise 2024. to te solutions by pharmacise 2022. ted to te solutions by pharmacise 2022. term te solutions by pharmacise 2022. term te solutions by pharmacise 2022. te s
3aqir 2017[20]	Medication review	Care homes	Retrospective evaluation of quality improvement project 422 residents in 20 care homes	Number and type of medicate to 19.5% reduction in number of medicate to baseline
'eek !020[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 vecks and by 40.7% (95% CI 29.1% to 54.2%, $p < 0.001$) at 12 months.
≀odgers 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 has ardous prescribing The PINCER intervention was associated with a decrease in the rate of hazardous prescribing of 16.2% (adjusted odds ratio (aOR) 0.83, 95% confidence interval (CB0.80 to 0.86) at 6 months and 15.3% (aOR 0.85, 95% CI 0.80 to 0.80 to 0.86) at 5 months post-intervention
yafhan 2021[17]	Pharmacist-led medicines optimisation	General practice	Individual RCT 356 patients at risk of	Medication-related problems (CRP); Medicines Appropriateness Index (MAI) Median number of MRPs per intervention patient at 6 months was

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			(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)		23-081	
			GP practices	appropriate) for the interve	scottes were reduced (ntion group, but not fo	medications more or control group.
Thayer 2021[23]	Review of medicines and lifestyle risk factors	Care homes for adults with intellectual	Service evaluation	Pharmacist interventions/realists	Amendations and a	acceptance by GPs
Twigg 2015[24]	Community pharmacist consultation including medication review	Community pharmacies	Service evaluation 620 patients (aged over 65 years and prescribed ≥ 4 medications	Number of recommendation of life and costs at 6 month	tention ac tention ac tention to the second tention to the second tention	lherence, quality
					http://bmjopen.bmj.com/ on June 12, 2025 a ES) .	
		For peer review	only - http://bmjopen.bmj.cc	- om/site/about/guidelines.xhtml	at Agence Bibliographique de l	15
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% Cl 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 decisionmaking were associated with high rates of changes to medication (1787 suggested changes from 574 reviews, 76% of which were implemented) and associated cost savings[39].

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 s achieveu . interventions and outcomes achieved in routine practice

ry of studies published a	as conference abstracts		:023-081934 on 7 right, including f
Population	Intervention	Study design	Outcome measures and key findings
Care home residents	Medication review by primary care pharmacists linked to GP practices	Service evaluation (retrospective analysis and interviews)	A total of 2916 in the presented 22%
Primary care patients taking ten or more medications	Polypharmacy clinics in GP surgeries	Service evaluation (retrospective data analysis)	Reductions in property and fing; cost savings; hospital admissions avoided and April 2017 to Marcine 2018, 370 patients reviewed and £50,766.63 saved and figures for April to December 2018 were 209 and £13,642, respectively
Patients recently discharged from hospital	Post-discharge medication review by clinical pharmacist linked to GP practice	Formative service evaluation (uncontrolled)	Medication changes were medications stopped
Patients referred by GPs	Polypharmacy review clinics led by pharmacist independent prescriber with shared decision-making	Service evaluation (uncontrolled)	Changes to medigation, feedback from patients and MDT Pharmacist medigation reviews were effective, with positive feedback received from patients and members of the MDT. Depreserventions and inhaler counselling were the most common interventions.
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 groe body a reduction in total number of medications when compared with non-intervention cohort. Anti-choliner fic burden scores were reduced by a mean of 26%
-	ry of studies published a Population Care home residents Primary care patients taking ten or more medications Patients recently discharged from hospital Patients referred by GPs Primary care patients living with frailty	ry of studies published as conference abstractsPopulationInterventionCare home residentsMedication review by primary care pharmacists linked to GP practicesPrimary care patients taking ten or more medicationsPolypharmacy clinics in GP surgeriesPatients recently discharged from hospitalPost-discharge medication review by clinical pharmacist linked to GP practicePatients referred by GPsPolypharmacy review clinics led by pharmacist independent prescriber with shared decision-makingPrimary care patients living with frailtyFrailty review involving pharmacist as part of MDT	PopulationInterventionStudy designCare home residentsMedication review by primary care pharmacists linked to GP practicesService evaluation (retrospective analysis and interviews)Primary care patients taking ten or more medicationsPolypharmacy clinics in GP surgeriesService evaluation (retrospective analysis)Patients recently discharged from hospitalPost-discharge medication review by clinical pharmacist linked to GP practiceFormative service evaluation (uncontrolled)Patients referred by GPsPolypharmacy review clinics led by pharmacist independent prescriber with shared decision-makingService evaluation (uncontrolled)Primary care patients living with frailtyFrailty review involving pharmacist as part of MDTService cohort

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herty Care home resid 20a[36], 20b[37]	dents Medicines Optimisation in Older People (MOOP) involving case management by pharmacists	Uncontrolled before/after	Finappropriate prescripting; unplanned hospital admissions, GP visits; clinical fitte ventions Inappropriate prescripting was highly prevalent at baseline (84.1%) but improver significantly from baseline (M = 14.87, SD = 13.1 fg from obseline (M = 2.04, Z = 25.97, pr≪4001).
inyai Patients aged a 17[33] least 75 years a prescribed 15 o more medicatio	t Pharmacist-led polypharmacy nd review clinic in primary care on	Survey	Patient satisfaction Of the 166 patient who returned a satisfaction questionnaire (40%) sponse rate), 83% found the service helpful, 13% did hef, 2% did not know and 2% did not respond
lovetsios Care home resid 18[39] needing palliati care	dents Structured medication ve reviews carried out in agreement with patient, nurse, family/carer and GP	Service evaluation	Changes to medi gation , estimated cost savings From January 20 reviews took place medication changes. Approximately 76% of these changes were agreed and ctioned by patients' GPs, with estimated saving of 169,986.96.
vift Care home resid 18[38]	dents 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 recommendation mg de to prescribers, 85% were accepted and resulted in a reduction in inappropriate polypharmacy
afhan Patients in 19[30] participating GF practices at risk MRPs	Pharmacist-supplemented care focusing on medication optimisation	Individual RCT	Number of mediation related problems (MRPs) and medication inappropriateness A total of 356 adult patients (175 control and 181 intervention) were recruited. Among 108 intervention patients who had the pharmacist face-to- face contacts, 346 MRPs were iden of the pharmacist and 83 MRPs at 6

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Table 4: Summar	ry of selected grey literature	case studies	-081934 on 7 t, including fo
Setting	Name of initiative	Key findings	u pointes commentation comment
Brighton and	An evaluation of a clinical	A total of 1,300 patients were referred into the service	The targed interview to frail or older
Hove CCG	pharmacist medication	and reviewed between April 2017 and March 2018; 9%	person
	review service in primary	of patients were deprescribed high-risk medicines	from sea the swithin GP clinical systems and
	care		through a start from clinical practitioners,
			voluntagy 🛱 d social care services
Swale CCG	Medicines Optimisation	In 2018/19, pharmacists and pharmacy technicians	Target 🛱 🖥 🛱 high-risk' patients
	Review Programme	reviewed 5281 patients and made 3859 interventions,	Key feater is use of technicians for less complex
		37% for adverse drug reactions (ADRs). Estimated in-	cases are fo
		year cost savings were £239,546	
NE Hampshire	Care homes pharmacist	Pharmacist accompanying GPs visiting care homes	Limited
and Farnham		carried out over 250 medication reviews and 800	9, 10
CCG		interventions. Average number of medicines per	l N tr
		resident fell from 9.4 to 7.6	
NE Hampshire	Polypharmacy	Tool developed by Wessex AHSN was used to identify	Limited state reported
and Farnham	prescribing comparators	patients at risk of harm, resulting in significant	an lic
CCG		reductions in percentage of patients aged over 75	d si
		prescribed 15 or more medications and percentage with	imii on
		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].

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.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].

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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. 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://pharmaceuticaljournal.com/article/news/nhs-england-removes-financial-incentives-for-structured-medicationreviews-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.

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Conflict of interest

The authors have no conflicts of interest to declare.

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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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	management within Northern Irish care homes. International Journal of
	Pharmacy Practice 2020, 28(Supplement 2):10.
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	Medicines optimisation in care homes via pharmacist case
	management: What is the impact on subsequent healthcare resource
	usage? International Journal of Pharmacy Practice 2020,
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8.	Swift A: Improving medicines optimisation for care home residents:
	Wigan Borough CCG's approach. Clinical Pharmacist 2018, 10(3).
39.	Kolovetsios M, Yones H: The Role and Impact of Pharmacists within a
	Hospice's Care Home Support Team. BMJ Supportive and Palliative
	<i>Care</i> 2018, 8(Supplement 2) :A83-A84.
0.	Avery AJ, Rodgers S, Cantrill JA, Armstrong S, Cresswell K, Eden M,
	Elliott RA, Howard R, Kendrick D, Morris CJ et al. A pharmacist-led
	information technology intervention for medication errors (PINCER): a
	multicentre, cluster randomised, controlled trial and cost-eff ectiveness
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11.	Croke A, Cardwell K, Clyne B, Moriarty F, McCullagh L, Smith SM: The
	effectiveness and cost of integrating pharmacists within general practice
	to optimize prescribing and health outcomes in primary care patients
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12.	Riordan DO, Walsh KA, Galvin R, Sinnott C, Kearney PM, Byrne S: The
	effect of pharmacist-led interventions in optimising prescribing in older
	adults in primary care: A systematic review. SAGE Open Medicine





2 3	SEAR	CH STRATEGIES in full (for Appendix / supplementary material)
4 5		
6 7	Ovid I	MEDLINE(R) ALL <1946 to February 06, 2023>
8 9	1	Inappropriate Prescribing/ 4485
10 11 12	2 essent	((hazardous* or excessive* or inappropriate* or unnecessar* or nonessential or non- tial or inessential) adj3 prescri*).mp. 8188
13 14	3	(overprescri* or over-prescri*).mp. 1975
15 16	4	Polypharmacy/ or (polypharmacy or poly-pharmacy).ti,ab. 12777
17 18	5	1 or 2 or 3 or 4 21236
19 20 21	6	exp Primary Health Care/ or (primary health care or primary healthcare or primary care).mp. 289526
22 23	7	general practice/ or family practice/ 78114
24 25 26	8 denta	(GP or general practi* or family practice or family physician* or community pharmac* or l or dentist* or optometr* or optician*).mp. 751694
27 28	9	6 or 7 or 8 997387
29 30	10	(deprescri* or de-prescri*).mp. 2577
31 32 33	11 shared	(structured medication review or medication reconciliation or medicine* optimi#ation or decision making or personalised care).mp. 16563
34 35 36	12 techni	((intervention* or initiative* or campaign*) adj3 (pharmacist* or pharmacy ician*)).mp. 3182
37 38	13	10 or 11 or 12 21842
39 40	14	5 and 9 and 13 540
41	15	*Medication Errors/ and 9 and 13 232
42 43	16	5 and 9 and pc.fs. 835
44 45	17	14 or 15 or 16 1416
46 47	18	limit 17 to yr="2013 -Current" 1152
48 49 50 51 52 53 54 55	19	remove duplicates from 18 1145
56 57		
20		

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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>

BMJ Open

 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

relievony

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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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11 12 13 14			Limiters - Published Date: 20130101-20231231 Expanders - Apply equivalent subjects	 Interface - EBSCOhost Research Databases Search Screen - Advanced Search 		
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17	S15	S6 AND S10 AND S14	(ABI ta m		327	
18 19	S14	S11 OR S12 OR S13	ining:		13,914	
20 21	S13	(intervention* or initiative* or campaign*) n3 pharmacist*	y, Al t	•	1,981	
22 23 24		"structured medication review" or "medication reconciliation" or "medicine* optimi#ation" or "shared decision making" or "personalised care" or "personalized	raining,			
25	S12	care"	and		10,941	
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28 29	S10	S7 OR S8 OR S9	ar tec		336,381	
30 31 32 33		("primary care" or "primary health care" or "primary healthcare" or "primary medical care") OR (GP or "general practi*" or "family practi*" or "family physician*" or "community pharmac*" or dental or dentist* or optometrist*	hnologies.			
34	S9	or optician*)	r Ag	•	333,015	
35 36	S8	(MH "Family Practice")	ence		26,910	
37 38	S7	(MH "Primary Health Care") OR (MH "Physicians, Family")	Bib		90,488	
39 40	S6	S1 OR S2 OR S3 OR S4 OR S5	lograph		12,727	
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44 45		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml 💆

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#6	#1 or #	2 or #3 or #4 or #5 2045
#7	MeSH	descriptor: [Primary Health Care] explode all trees 9989
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#9	MeSH	descriptor: [Family Practice] explode all trees 2242
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#13	MeSH	descriptor: [Deprescriptions] explode all trees 68
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#16	((interv 1559	ention* or initiative* or campaign*) near/3 (pharmacist* or pharmacy)):ti,ab,kw
#17	#13 or	#14 or #15 or #16 4166
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(3 reviews, 127 trials)

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

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Study ID	Study design/sample size	Setting	Intervention	Key findings	Authors' conclusion fe Son trupoad an er	Study strengths/limitations
Alharthi	Secondary	Care homes	Integration of	Factors that acted as both	PiPs' involvem 🛱 🖉 🛱 care homes	Strengths: Diverse
2023[18]	analysis of	in England	PIPs into care	enablers and barriers were PIP	is influenced by എന്റെ മ്പ്ലാം	PIP contexts and
	qualitative	and	homes to	relationship with General	barriers and en at a state of the state of t	perspectives on
	interview data	Scotland	improve	Practitioner (GP), care home	be addressed t	deprescribing;
			medication	staff and residents/families,	intervention effectiveness	theory-informed
	11 pharmacist		management	awareness of the PIP role and	Al tr	analysis using
	independent			family trust in PIPs'	ain per	Theoretical Domains
	prescribers			deprescribing activities (social	ling	Framework to
	(PIPs) who			<i>influences</i>); PIPs' independent	, anj.	identify barriers and
	participated in			prescribing confidence, previous	nd s	enablers
	a cluster			experience and ability dealing	sim vo	
	randomised			with residents' medications	liar J	Limitations: Only PIP
	trial			(beliefs about capabilities);	tec	perspective
				understanding of PIP role and	hn 12	considered; analysis
				PIP confidence in their role as an	, 20	used data from
				independent prescriber	gie:	interviews focused
				(social/professional role and	at /	on the whole
				identity); access to residents'	- Jge	intervention process
				records, deprescribing decision	n n n n n n n n n n n n n n n n n n n	rather than
				support, regular follow-up from	B	exclusively on
				care home staff, resident	blic	deprescribing
				difficulties with medications,		
		F	or peer review onl	y - http://bmjopen.bmj.com/site/abou	it/quidelines.xhtml	

				BMJ Open	njopen-2023-08 by copyright, i	
				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.	31934 on 7 August 2024. D Enseigneme ncluding for uses related 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 reverses undertaken by primary care to the maximum and the maximum	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 year, annualised cost savings were estimated at £65,471	Medicines optimisation reviews can lead to a reduction in polypharmacy for care home residents through a deprescribing pocess. Patients' medicine reginatens simplified and optimised while making financial sayings for the NHS	Strengths: Compares two approaches to delivering medication 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 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	The intervention with generally implemented again and well-received by most stakeholders. Whilst there was swill espread deprescribing, contract of the state of	Strengths: Involve three UK nations of differing healthca systems; used stu records to supplement qualitative data Limitations: Interv participants may no be representative limited access to of 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).	Pharmacists judged 72% (95% CI 70, 74; 1463/2026) of cases of hazardous medicines management to be clinically	Recommendations from the pharmacists were be oddly	Strengths: Uses d from a large clust RCT

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26	radius	Patients	relevant. Pharmacists	acceptable to Ges and led to	Limitations:
30 internetien	arounu Manakastan	potentially at	recommended 2105		Pharmacists did n
Intervention	Manchester	risk from	Interventions in 74% (95% CI 73,	majority of cases. It seems	record detailed
and 36 control	and Nettinghous	nazardous	16; 1516/2038) of cases and	the DINCED show In the appropriate sould	reasons for their
practices; 1946	Nottingnam	medicines	1685 actions were taken in 61%	the PINCER phage age is to could	Judgements and
patients		management	(95% CI 59, 63; 1246/2038) 01	the employed by Solo	these were not p
identified as at		were	Cases; 66% (95% CI 64, 68;		reviewed
risk in		Identified	1383/2105) of interventions	following appropriate training.	
Intervention		using Quest	recommended by pharmacists	tex	
practices		Browser	were completed and 5% were	t a	
		software to	accepted by GPs but not	nd c	
		search GP	completed at the end of the	fro data	
		electronic	pharmacists placement; the		
		records.	remaining recommendations		
		Intervention	were rejected or considered not	ig. · j	
		practices were	relevant by GPS.	Alt	
		assigned a		raii	
		pharmacist		nin b	
		who educated		g, a	
		practice staff	- N		
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		management		Jun r te	
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		Pharmacists		Ag	
		also reviewed			
		cases of		Се	
		potentially		Bib	
		hazardous		liog	
		medication		Jra	

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 practices (9

pharmacists, 7

other GP staff)

GPs, 12

71					BMJ Open	mjopen-2023- I by copyright,	
	Jeffries 2017[13]	Qualitative realist evaluation	CCG in the South of	and recommended interventions to GPs Electronic Medicines Optimisation	Effective use of the EMOS depended upon engagement with the system, the flow of	The use of an erection system may improve medicines optimalized without safety	Strengths: Realist methodology enabled detailed
		Interviews: 3 GPs, 2 CCG pharmacists; Focus groups: 2 GPs, 4 community pharmacists, 4 patients, 4 practice managers	Lingianu	System (EMOS). The EMOS is intended to facilitate clinical audits of prescribing activity to identify patients at risk of adverse drug events (ADEs)	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.	in primary care of an ADE. To fails be there needs to be the needs	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	43 general practices in Salford, Greater Manchester	Electronic audit and feedback surveillance dashboard to identify patients	Engagement with the dashboard involved a process of 'sense- making' by pharmacists. The intervention helped to build respect, improve trust and develop relationships between pharmacists and GPs.	potential benefits. Medicine optimesaton in primary care may be enhanced by the implementation of a pharmacist-led electronic audit and feedback sester. This intervention estably hed a rapid learning health system that	Strengths: Use of Normalization Process Theory as a framework to understand implementation

~

enabled data from **G**lectronic

health records to $\mathbf{b}\mathbf{\hat{s}}$ used to

make changes in practice to

improve patient car.

Limitations:

of follow-up

developed the

Evaluation team also

intervention; number

Collaboration and

communication between

primarily initiated by

pharmacists and clinicians was

potentially at

prescribing or

risk of

hazardous

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ane Qualita 2020[22] focus g and int 85 (72 groups in sem structu intervi	itative s groups interviews 72 in focus ps and 13 mi- ctured views)	Care homes (4 sites in England (2), Scotland and Northern Ireland)	monitoring of medicines Integration of PIPs into care homes to take responsibility for medicines management	pharmacists and was important for establishing the intervention. 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 team- working and ensuring role clarity. Introducing a PIP was welcomed in principle	The overarching the from this research was the growth of the overarching the growth of the from this research was the growth of the from the second of the s	interviews was limited Strengths: Purposively selected sample; use of TDF as a framework to analyse data Limitations: Data relate to proposed service model in advance of implementation
ane Qualita 2020[22] focus a and int 85 (72 groups in sem structu intervi	itative s groups interviews 22 in focus ps and 13 mi- ctured views)	Care homes (4 sites in England (2), Scotland and Northern Ireland)	medicines Integration of PIPs into care homes to take responsibility for medicines management	for establishing the intervention. 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 team- working and ensuring role clarity. Introducing a PIP was welcomed in principle	The overarching the from this research was the service must "understand from http://bmjop need to understand from http://bmjop systems in advant for and from http://bmjop	limited Strengths: Purposively selected sample; use of TDF as a framework to analyse data Limitations: Data relate to proposed service model in advance of implementation
ane Qualita 2020[22] focus a and int 85 (72 groups in sem structu intervi	itative s groups interviews 72 in focus ps and 13 mi- ctured views)	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 team- working and ensuring role clarity. Introducing a PIP was welcomed in principle	The overarching the from this research was the service must "understand for the service systems". In pactor of need to understand for the service systems in advant for the service implementing at the service and data mining, Al training at the service	Strengths: Purposively selected sample; use of TDF a a framework to analyse data Limitations: Data relate to proposed service model in advance of implementation
2020[22] focus g and int 85 (72 groups in sem structu intervi	s groups interviews 72 in focus ps and 13 mi- ctured views)	(4 sites in England (2), Scotland and Northern Ireland)	PIPs into care homes to take responsibility for medicines management	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 team- working and ensuring role clarity. Introducing a PIP was welcomed in principle	research was the severy one must "understand ach other's systems". In patient ach other's need to understand care homes' systems in advand find and the service implementing at the service data mining. Al training and the service	Purposively selected sample; use of TDF a a framework to analyse data Limitations: Data relate to proposed service model in advance of implementation
and in 85 (72 groups in sem structu intervi	interviews 2 in focus ps and 13 mi- ctured views)	England (2), Scotland and Northern Ireland)	homes to take responsibility for medicines management	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 team- working and ensuring role clarity. Introducing a PIP was welcomed in principle	must "understandig Gach other's systems". In particular, PIPs need to understandig Gare homes' systems in advance of implementing a gard be service and data mining, Al training	sample; use of TDF a a framework to analyse data Limitations: Data relate to proposed service model in advance of implementation
85 (72 groups in sem structu intervi	72 in focus ps and 13 mi- ctured views)	Scotland and Northern Ireland)	responsibility for medicines management	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 team- working and ensuring role clarity. Introducing a PIP was welcomed in principle	systems". In patient war, PIPs need to understand care homes' systems in advance of implementing a price of data mining, Al training, Al training	a framework to analyse data Limitations: Data relate to proposed service model in advance of implementation
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			· · · C	medicine, and implementation barriers in integrated team- working and ensuring role clarity. Introducing a PIP was welcomed in principle	om http://bmjop ABES) . a mining, Al trai	advance of implementation
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				but conditional on: a clearly	₹ 9	
				defined PIP role communicated	n.b	
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				residents and relatives.	tec	
Madden Qualita	itative	General	Structured	SMR implementation was largely	Early implement ation of SMRs	Strengths: based on
2022[14] intervi	view	practice in	medication	delegated to individual	did not match the intention of	detailed, in-depth
study	y	England	review (SMR)	pharmacists. Established	providing patie	interviews
			for people at	pharmacists appeared more	review and shared secision-	
10 nev	ewly		risk of harm or	ready for implementation than	making. The author identified	Limitations: Authors
appoir	ointed		medication-	newly appointed staff. New	an important oppo	note interviews need
pharm	macists		related	pharmacists were learning about	of SMR 🖁	to be complemented
workir	king in		problems	working in primary care settings	implementation wiffiout prior	by data on actual
primar	ary care			and tended to follow procedures	adequate skills	

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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, testift, and refining for uses related to te	practice and term follow-
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% Cl 20.3% to 36.8%, $p <$ 0.001) at 24 weeks and by 40.7% (95% Cl 29.1% to 54.2%, $p <$ 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 integration was associated with recent ced rates of potentially haz for some ced rates of prescribing and for some ced rates of prescribing but for some ced rates of monitoring for some ced rates of monitoring for some ced rates of monitoring for some ced rates of prescribing but for some ced rates of marked reduction of hazardous prescribing for some ced rates of between practices. June 12, 2025 at prescribing for some ced rates of hazardous prescribing for some ced rates of hazardous prescribing for some ced rates of hazardous prescribing for some ced rates of hazardous prescribing for some ce	Strengths: An noted pragm design, evalu clinically rele outcomes an number of p taking part Limitations: randomised possibility of unrecognised confounding be excluded

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Rodgers 2022[16]	Multiple interrupted	General practice in	and initiating remedial actions or advising GPs on doing so. Pharmacist-led IT intervention	(95% CI 0.2% to 50.7%, $p =$ 0.046) at 24 weeks; the change at 12 months (23.5%) was no longer significant (95% CI –4.5% to 61.6%, $p = 0.127$). 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	in cluding for uses related to textual to te	Strengths: Suggests intervention was
	time series 393 general practices covering approximately 3 million patients	the East Midlands region of England	to reduce hazardous prescribing (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	clinical practice was associated with a reduction and 12 months to see a second	implemented successfully in routine practice and was associated with significant reduction in hazardous prescribing Limitations: The authors adjusted fo calendar time and practice, but since this was an observational study the findings may have been influence by unknown confounding factors or behavioural changes unrelated t
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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 (<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	including for uses related to text and the pharmacist of medications and similar technologies. The pharmacist of medications in a cost-effect A training, and similar technologies.	the PINCER intervention. I were also not collected for a practices at 6 months post- intervention Strengths: Pra randomised d Limitations: Sa smaller than planned; high follow-up; MR analysis only c patients who attended 3 appointments
				attendances or outpatient visits. The mean overall healthcare	bliogra	

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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 ($p = 0.032$). 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 \geq 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.	There was conserved to text and the residents and and the resident of the resident o	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 imgrove	Strengths: Large sample of patients and providers; use of

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71			BMJ Open	mjopen-2023-08 by copyright, ir	
	620 patients (aged over 65 years and prescribed ≥ 4 medications)	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 for the first 6 months of participation in the service.	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.	medicine adhered on 7 August 2024. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliog Enseignement Superieur (ABES) . Enseignement Superieur (ABES) . Enseignement Superieur (ABES) .	t validated outcome measures Limitations: No control/comparato group; authors note some patients were probably reviewed independently by their GP during the study period; relatively high attrition rate

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Appendix Table 2: TIDieR Lite for UK pharmacis	t studies

Appendix Table	2: TIDieR Lite for UK ph	BM armacist studies	J Open	by copyright, including	mjopen-2023-081934 on 7	
Intervention name and study ID(s)	By whom	What	Where	Intensity Intensity reig	7 August 20	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, care home, medication 	Participating care homes	PIPs committed a mediate provided categorie provided categorie provided categories and data mining, Al training, and similar technologies.	The service. The service. Approximately approximately added from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliogr	PIPs visited care homes weekly over 6 months

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		supplying community pharmacy and study team		1934 on 7 <i>A</i> 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 support allocated for the service was a support allocated mean of the service was a support of the	The aim of the programme was offer at least one visit to as many care homes as possible (appears to be one visit pe 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 decision- making) 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 intervention of reported. Prescribing decision could be made by pharmacists alone of in conjunction with GPs and similar technologies. Agence Bibliogram	Once, as a funde quality improvement (Q 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.			31934 on 7 August 20 Enseign	
PINCER Pharmacists specifica trained to deliver the intervention; GPs, ot 2014[11]; practice staff and Rodgers pharmacy technician 2022[16] involved in implementation	 Ily 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 re Midlands, time spen delivering the interv CCG depending on t of the local Medicine Team	boot in the East out in the East dout in	Data collected quarterly up to 12 months after starting the intervention[16]

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		ВМ	JOpen	open-2023-08 r copyright, in	
		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		1934 on 7 August 2024. Downloaded from http://bm Enseignement Superieur (ABES) . cluding 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 (qualitativity), and similar technologies.	Not reported (qualitative stu

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		BM.	l Open	njopen-2023-08 by copyright, i	
		Patients can access the system through a "Patient Passport"		ncluding	
Safety C Medication w dASHboard p (SMASH) g Jeffries 2018[12]; Peek 2020[15]; Jeffries 2020[26]	Clinical pharmacists vorking 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 the mathematical artile range, 5.0–15.2) times per mathematical artile range, during the first quarter of the dashboard towards regular but the source of the dashboard used in the source of the dashboard used in the dashboard towards regular but the source of the dashboard used in the source of the dashboard use was higher in practice of the dashboard use was higher in practice in the dashboard use of at-risk partice of the dashboard use of the dashboard use was higher in practice of the dashboard use was higher in practice of the dashboard use was higher in practice of the dashboard use of the dashboard use was higher in practice of the dashboard use was higher in practice of the dashboard use use was higher in practice of the dashboard use use was higher in practice of the dashboard use use the dashboard use use the dashboard use use the dashboard use use higher in practice of the dashboard use use higher in practice of the dashboard use use use higher in practice of the dashboard use use higher of the dashboard use	Dashboard was updated daily. Frequency of use varied by practice and over time (see previous column)
Structured C Medication w Review (SMR) p (F Madden 2022[14]; Stewart 2021[27]	Clinical pharmacists vithin 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 lease 30 minutes to allow time for share decision-making 12, 2025 at	Once
Medicines G optimisation p intervention as p	GP practice-based pharmacists operating is 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 appointments available of 2 and 4 months building on patient progress towards agreed goals	Once per patient (up to three appointments)

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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 administration devices and Cluding for uses related to the set set of the set of
	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	507 interventions/rediged as 3 per 160 residents revieved as 3 per resident) 7 August 2024. Downloaded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliograph Enseignement Superieur (ABES) . Al training, Al training, and similar technologies.	Once

Page 63 of 71			BM	IJ Open	omjopen-202 1 by copyrig	
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33	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	Pharmacist time estimation, 10 minutes for monthla BES) . Pharmacist time for quarter bining, and similar technologies.	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 a旋亞亞riate to answer the research
2023[18]	questions? Yes		question? Yes (identifying perceive ្ដ្ឋី ខ្ញុំព្រុះriers and facilitators)
			1.2. Are the qualitative data colle a b we have a colle
			research question? Can't tell (seco ဆိုဆိုပ်ပွဲ analysis of existing data)
	S2. Do the collected data allow		1.3. Are the findings adequately derayed from the data? Yes
	to address the research		1.4. Is the interpretation of result紫頸d ciently substantiated by data? Yes
	questions? Yes		1.5. Is there coherence between අමුණුම්ත්ර්ප data sources, collection,
			analysis and interpretation? Yes (នីដ្ឋីដ្ឋិហិថ្មីrted by use of Theoretical Domains
			Framework) ដី <u>ទ</u> ុទ្ធ
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 rearding 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) ខ្ម 🦉
			3.5. During the study period, is the intervention administered (or exposure
			occurred) as intended? Can't tell (<u>B</u> deley 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 ᅙ ᠔
	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 क्षि in the design and analysis? No
			(uncontrolled before/after study) ត្ត
			3.5. During the study period, is the intervention administered (or exposure
			occurred) as intended? Can't tell (integentions not externally validated)
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			right, in
Birt 2021[21]	S1. Are there clear research	Mixed methods	5.1. Is there an adequate rational \vec{E} for \vec{E} using a mixed methods design to
	questions? Yes		address the research question? Y ϵ ថ្និ (q \hat{b} alitative and quantitative data
			relevant to process evaluation) $\frac{2}{5}$
			5.2. Are the different components of the study effectively integrated to
	S2. Do the collected data allow		answer the research question? Yes and discussion)
	to address the research		5.3. Are the outputs of the integration of qualitative and quantitative
	questions? Yes		components adequately interpret a we want the set of th
			5.4. Are divergences and inconsist and between quantitative and
			qualitative results adequately addressed? Yes (page 11 column 2)
			5.5. Do the different components 🍯 🛱 👼 study adhere to the quality
			criteria of each tradition of the metrodition of t
Howard	S1. Are there clear research	Quantitative	4.1. Is the sampling strategy relev 新花 段 address the research question?
2014[11]	questions? Yes	descriptive	Yes
			4.2. Is the sample representative d 前置 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 low? 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 approa
2017[13]	questions? Yes		question? Yes (explored factors perceiged to affect adoption and
			implementation)
			1.2. Are the qualitative data colle diomethods adequate to address the
	S2. Do the collected data allow		research question? Yes (interview sand focus groups)
	to address the research		1.3. Are the findings adequately derived from the data? Yes (context-
	questions? Yes		mechanism-outcome groups identi dent
			1.4. Is the interpretation of results sufficiently substantiated by data? Ye
			1.5. Is there coherence between qualizative 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 appropriate to answer the research
2018[12]	questions? Yes		question? Yes (explored factors perceized to affect adoption and
			implementation)
			ohic .
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	S2. Do the collected data allow		1.2. Are the qualitative data collection methods adequate to address t
	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?
			(supported by relevant quotes)
			1.5. Is there coherence between qualitative data sources, collection,
			analysis and interpretation? Yes (analysis and interpretation? Yes)
			Theory)
Lane	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach approa
2020[22]	questions? Yes		question? Yes (gather opinions ab 🕰 គ្នី oposed service)
			1.2. Are the qualitative data colleອີ່ເອີ້ມຮິກmethods adequate to address t
			research question? Yes (focus groរឆ្នាំទីផ្ទុំជាd interviews with different staff
	S2. Do the collected data allow		groups at different sites) 章論
	to address the research		1.3. Are the findings adequately dermined from the data? Yes
	questions? Yes		1.4. Is the interpretation of result
			📄 (supported by relevant quotes) 🛛 🧕 📓
			1.5. Is there coherence between chalinative data sources, collection,
			analysis and interpretation? Yes (gipp brted by use of Theoretical Doma
			Framework) 🦉
Madden	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach appropriate to answer the research
2022[14]	questions? Yes		question? Yes (pharmacists' experience of SMR implementation)
			1.2. Are the qualitative data colle
			research question? Yes (interviews with newly employed and establishe
	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 substantiated by data?
			(supported by relevant quotes)
			1.5. Is there concrete between quality two data sources, conection,
Pook	S1 Are there clear recearch	Quantitativo non	2 1 Are the participants representative of the target nonulation? Vec
2020[15]	auestions? Ves	randomised	σ_{append} and σ_{append} σ_{append}
2020[13]	4463110113: 763		3.2 Are measurements appropriate reparding both the outcome and
			intervention (or exposure)? (an't tell that intervention)

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	S2. Do the collected data allow		3.3. Are there complete outcome hata 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)
	4		3.5. During the study period, is the intervention administered (or exposure
			occurred) as intended? Can't tell (and tell and
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 patients)
			3.2. Are measurements appropriate agarding both the outcome and
			intervention (or exposure)? Can't ten for intervention)
	S2. Do the collected data allow		3.3. Are there complete outcome केंद्रि क No (6- and 12-month data not
	to address the research	6	collected from all practices) ခြို့ ဗိုးမီ
	questions? Yes		3.4. Are the confounders account क्यमिंक्से in the design and analysis? No
			(small risk of unmeasured confounថ្មីរ៍ត្ត្រឿ
			3.5. During the study period, is th를 滅煙rvention administered (or exposure
			occurred) as intended? Can't tell (tell (tell (tell tell)
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 againe? Yes
			2.3. Are there complete outcome
	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 electro
			2.5 Did the participants adhere to the ssigned intervention? No (30% lost
			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 diabilities)
			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		associatea outcomes)
	to address the research		3.3. Are there complete outcome data? Yes (all specified outcomes
	questions? Yes		
			3.4. Are the contounders accounted to in the design and analysis? No
			(uncontrollea before/after stuay)

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			1-2023-08 9yright, i
			3.5. During the study period, is the study period is the study period.
			occurred) as intended? Yes (one-off review mainly based on record
Twigg	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population?
2015[24]	questions? Yes	randomised	(no indication of attempts to recruit a \Bbbk presentative sample)
			3.2. Are measurements appropria and a second s
			intervention (or exposure)? Yes (data to recorded for intervention
	S2. Do the collected data allow		components and associated outcoឱ្យឝ្វីឝ្ទីឝ្វី
	to address the research		3.3. Are there complete outcome प्रैंकों के Can't tell (limited response
	questions? Yes		resource use outcomes)
			3.4. Are the confounders account දිස් දි ක් in the design and analysis
		6	(uncontrolled before/after study) គ្នី 🛱 ក្ល
			3.5. During the study period, is th会前话 rention administered (or
			occurred) as intended? Can't tell (ဗိုက္ရွိခြံသူး. 30% withdrawal rate)
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PRISMA 2020 Checklist

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1 2	PRISM	MA 20)20 Checklist	
3 4 5	Section and Topic	ltem #	Checklist item	Location where item is reported
6	TITLE			
7	Title	1	Identify the report as a systematic review.	Title
8	ABSTRACT			
9 10	Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p2
10	INTRODUCTION	<u> </u>		
12 13	Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction (pp4-5)
14	Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Methods (p6)
15	METHODS			
16	Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Methods (p6)
17 18	Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consuled to the date when each source was last searched or consulted.	Methods (p7)
19 20	Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used	Supplementary file
21 22 23	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 a screened in the process.	Methods (p7)
23 24 25 26	Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, 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)
20 27 28	Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which esures to collect.	Methods (pp7- 8)
29 30		10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, and g sources). Describe any assumptions made about any missing or unclear information.	Methods (pp7- 8)
31 32	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)
33 34	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)
35 36	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)
37 38		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
39 40		13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	N/A (summary tables only)
41 42		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 a	N/A
43 ДЛ		13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analy 🖣 s, meta-regression).	Methods (p8)
45		13f	Describe any sensitivity analyses conducted to assess cool assess conducted to assess cool at the strategy and the strategy a	N/A
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PRISMA 2020 Checklist

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1	PRISM	MA 20)20 Checklist	
3 4 5	Section and Topic	ltem #	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 as b).	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			
11 12	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
13 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) are the stimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Tables 1-4 where available and appropriate
24	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 summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the gire ation of the effect.	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	Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed	N/A
30 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			
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.	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)

Provide registration information for the review, including register name and registration number, or state that the review was not registered.

Title page

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OTHER INFORMATION

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Registration and



PRISMA 2020 Checklist

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1 2	PRIS MAN	SMA 20	020 Checklist	
3 4 5	Section and Topic	ltem #	Checklist item	Location where item is reported
6	protocol	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Title page
7		24c	Describe and explain any amendments to information provided at registration or in the protocol.	P9
0 9	Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in a me	Title page
10 11	Competing interests	26	Declare any competing interests of review authors.	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 forms that a extracted from incl studies; data used for all analyses; analytic code; any other materials used in the review.	uded Data sharing statement (p30)
16 17 18 19 20 21 22 23 24 25 26 27 28 29	From: Page MJ, Mcł	Kenzie 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/	171. doi: 10.1136/bmj.n71
30 31 32 33 34 35 36 37 38 39 40 41 42 43 44			une 12, 2025 at Agence Bibliographique de rechnologies.	
45 46 47			For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml	

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

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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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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.

- Many of the studies lacked a control group and the research took place in a highly complex and evolving system, meaning that results could have been influenced by confounding factors such as other interventions in the health and social care system.
 - Some review processes were performed by a single reviewer and meta-analysis was not feasible.

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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

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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

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:

- i. 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.

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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;	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.

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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).

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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.

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able 1: Sumi	mary of research study charad	cteristics		-2023-081934 on yright, including
Reference	Population	Intervention	Study design	or → Ogtcome measures
Quantitative	controlled studies	1		es s st
Howard 2014[13]	Pharmacists delivering intervention	IT-enabled pharmacist-led review to reduce medication errors	Cluster RCT (PINCER trial)	T표별 용ken to complete reviews; re률gimmended interventions and wheth the 알 were 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	Reference) of potentially hazard personal provide the second seco
Rodgers 2022[18]	General practices in the East Midlands	Pharmacist-led IT intervention (PINCER)	Multiple interrupted time series	Inguesors of potentially hazardous
Syafhan 2021[19]	Patients in participating GP practices at risk of MRPs	Pharmacist-supplemented care focusing on medication optimisation	Individual RCT	Ngmber of medication related problems (NgRP) and medication inappropriatene
Quantitative	uncontrolled studies	-	CI.	α <u>τ</u> .
Alves 2019[21]	Care home residents	Medication review by primary care pharmacists linked to GP practices	Service evaluation (5 year uncontrolled study)	Interventions by pharmacist (including depresentions 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	Ngmber and type of medications stoppe
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	P armacist interventions/recommendations and acceptance by GPs and psychiatrists

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Twigg	Patients over 65	Community pharmacist consultation	Service evaluation	Nember of recommendations; falls,
2015[26]	prescribed four or more medications	including medication review using STOPP/START rules		ngedication adherence, quality of life and
Qualitative/	mixed methods			
Alharthi 2023[20]	Care home residents	Deprescribing by pharmacist independent prescriber	Qualitative interviews with participants in a cluster RCT (CHIPPS study)	Barreigness reigness ate book to to to to to to to to to to to to to
Birt 2021;[23]	Care home residents	Pharmacist independent prescribers responsible for medicines management (CHIPPS)	Mixed methods process evaluation	Pr Sourceived benefits and bar and ban
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 Bes related to implementation of the integration and role of practice pearmacists and others
Jeffries 2017[15]	Stakeholders in general practice and CCG	Electronic medicines optimisation	Qualitative realist evaluation	Seggetions 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	Perceived benefits of the service and barries 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	The mess related to early implementation of Son R Service

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Alves 2019[21]	Medication review	Care homes	sample size Service evaluation 10,405 patient reviews over 5 years	Interventions by pharmacisated to te so
Baqir 2017[22]	Medication review	Care homes	Retrospective evaluation of quality improvement project 422 residents in 20 care homes	Number and type of medications stopped 19.5% reduction in number of medications being prescribed relative baseline
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 vertex 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 hard dus prescribing The PINCER intervention was associated with a decrease in the rate of hazardous prescribing of 16.2% (adjusted odds ratio (aOR) 0.83, 95% confidence interval (CP0.80 to 0.86) at 6 months and 15.3% (aOR 0.85, 95% CI 0.80 to 0.80 to 0.86) at 2 months post-intervention
Syafhan	Pharmacist-led medicines	General practice	Individual RCT 356 patients at risk of	Medication-related problems (@RP); Medicines Appropriateness Index (MAI) Median number of MRPs per intervention patient at 6 months was
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			problems (MRPs) from 8 GP practices	intervention schedule. MAI appropriate) for the interve	coges were	reduced (medications more but not for control group.
Thayer 2021[25]	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/realist and psychiatrists	configurendat Enseigne	ions and acceptance by GPs
Twigg 2015[26]	Community pharmacist consultation including medication review	Community pharmacies	Service evaluation 620 patients (aged over 65 years and prescribed ≥ 4 medications	Number of recommendation of life and costs at 6 months	ngnt Superieur	lication adherence, quality
				mining, Al training, and similar technologies.	n http://bmjopen.bmj.com/ on June 12, 2025 at BES)	
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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% Cl 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-

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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 s achieveu . interventions and outcomes achieved in routine practice

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able 3: Summa	ry of studies published a	as conference abstracts		1934 on 7 / Including for
Reference	Population	Intervention	Study design	Outcome measures and key findings
Alves 2016[30]	Care home residents	Medication review by primary care pharmacists linked to GP practices	Service evaluation (retrospective analysis and	Interventions by ង៉ឺឆ្លៃឆ្នាំmacist; barriers and facilitators A total of 2916 in អ្នំថ្មី kind in the made in 1047 patients of which deprescripging represented 22%
		<u> </u>	interviews)	l to
Bryant 2019[33]	Primary care patients taking ten or more medications	Polypharmacy clinics in GP surgeries	Service evaluation (retrospective data analysis)	Reductions in programming; cost savings; hospital admissions avoiding 2018, 370 patients reviewed and £50,766.63 save 2018, ires for April to December 2018 were 209 and £13, brz, 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 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 medigation, feedback from patients and MDT Pharmacist medigation reviews were effective, with positive feedback received from patients and members of the MDT. Depressripping 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 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-choliner ic burden scores were reduced by a mean of 26%
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Doherty 2020a[38], 2020b[39]	Care home residents	Medicines Optimisation in Older People (MOOP) involving case management by pharmacists	Uncontrolled before/after	Inappropriate prescripting; unplanned hospital admissions; GP visits; clinical interventions Inappropriate prescripting was highly prevalent at baseline (84.1%) but improved significantly from baseline (M = 14.87, SD = 13.1 from baseline (M = 2.04, 7 = 25.97, m (M)
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 Of the 166 patient source of the 166 patient source of the 166 patient source of the service of the servi
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 medie ion, estimated cost savings From January 20 20 20 January 2018, 574 medication reviews took place is sulting in 1787 suggested medication changes. Approximately 76% of these changes were agreed and ctoned by patients' GPs, with estimated saving 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 Agust 2014 and March 2017. Of the recommendation mg de 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 all patients (175 control and 181 intervention) were recruited. Among 108 intervention patients who had the pharmacist face-to- face contacts, 346 MRPs were iden offied at baseline and 83 MRPs at 6 months. Median values were 3 MRPs at baseline and 1 at 6 months (p<0.001).
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Table 4: Summar	y of selected grey literature	case studies	-081934 on 7 , including fc
Setting	Name of initiative	Key findings	Comments/5
Brighton and	An evaluation of a clinical	A total of 1,300 patients were referred into the service	The targed based in the targed based on targed bas
Hove CCG	pharmacist medication	and reviewed between April 2017 and March 2018; 9%	person
	review service in primary	of patients were deprescribed high-risk medicines	from seक्रेंट्रिफ्टिs within GP clinical systems and
	care		through a start from clinical practitioners,
			voluntagva <u>B</u> d social care services
Swale CCG	Medicines Optimisation	In 2018/19, pharmacists and pharmacy technicians	Target 🛱 🖥 🙀 high-risk' patients
	Review Programme	reviewed 5281 patients and made 3859 interventions,	Key feater is use of technicians for less complex
		37% for adverse drug reactions (ADRs). Estimated in-	cases and for
		year cost savings were £239,546	
NE Hampshire	Care homes pharmacist	Pharmacist accompanying GPs visiting care homes	Limited temported
and Farnham		carried out over 250 medication reviews and 800	9. Nor
CCG		interventions. Average number of medicines per	
		resident fell from 9.4 to 7.6	
NE Hampshire	Polypharmacy	I ool developed by Wessex AHSN was used to identify	
and Farnnam	prescribing comparators	patients at risk of narm, resulting in significant	an <mark>li</mark> o
CCG		reductions in percentage of patients aged over 75	d si m
		prescribed 15 or more medications and percentage with	imil
		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].

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.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].

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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://pharmaceuticaljournal.com/article/news/nhs-england-removes-financial-incentives-for-structured-medicationreviews-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.

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Conflict of interest

The authors have no conflicts of interest to declare.

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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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Data extraction tables

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

Data extr Table 1: St	action tables cudy characteristi	ics of included	d research studie	BMJ Open	njopen-2023-081934 on 7 August 2024. Enseignem sy copyright, including for uses related	
Study ID	Study design/sample size	Setting	Intervention	Key findings	Authors' conclus and the second secon	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 difficulties with medications,	PiPs' involvemed eine care homes is influenced by presenter ous barriers and enality for the care homes is influenced by presenter ous barriers and enality for the care homes be addressed to the care homes intervention effective intervention effective and similar technologies. Bibliogra	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

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				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.	-08/1934 on 7 August 2024. C Enseigneme t, including for uses related	
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 undertaken by primary care to a wide range of intervations, commonly involutions deprescribing.	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 year, annualised cost savings were estimated at £65,471	Medicines optimisation reviews can lead to a reduction in polypharmacy for care home residents through a deprescribing process. Patients' medicine regine ns were simplified and optimised while making financial sayings for the NHS	Strengths: Compares two approaches to delivering medication 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 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	The intervention with generally implemented as intended, and well-received by most stakeholders. Whilst there was statespread deprescribing, contraction effected PIP entraction pathways between entraction pathways between entraction pathways between entraction pathways between entraction pathways between entraction pathways between entraction previously established.	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
Howard 2014[11]	Process evaluation of data from cluster RCT	General practice surgeries in an 80 km	Pharmacist-led IT enabled intervention (PINCER).	Pharmacists judged 72% (95% Cl 70, 74; 1463/2026) of cases of hazardous medicines management to be clinically	Recommendations from the pharmacists were be oddly	Strengths: Uses data from a large cluster RCT

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36 intervention and 36 control practices; 1946 patients identified as at risk in intervention practices	radius around Manchester and Nottingham	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 also reviewed cases of potentially hazardous medication	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.	acceptable to Ges and led to ameliorative action in the majority of cases. It seems likely that the appreciation used by the PINCER phase is could be employed by element Superior transition other practice leginer acists following appropriate training, and similar technologies.	Limitations: Pharmacists did no record detailed reasons for their judgements and these were not per reviewed

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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	to GPs 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 erection is medicines optimited in system may improve medicines by identifying those to the potential benefities of the potential benefities of the potential benefities of the utilisation across for mary care and with a wide to the potential stake bolds rs and users prior to implementation might allay perceptions that the system is owned centrally and increase knowledge 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 'sense- making' 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 optimesaton in primary care may be enhanced by the implementation of a pharmacist-led leteronic audit and feedback soster. This intervention established a rapid learning health system that enabled data from electronic health records to be used to make changes in prectice to improve patient care.	Strengths: Use of Normalization Process Theory as a framework to understand implementation Limitations: Evaluation team also developed the intervention; numbe of follow-up

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			monitoring of medicines	pharmacists and was important for establishing the intervention.	1934 on 7 Icluding f	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 team- working 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 care- home staff; and dialogue about developing the service with residents and relatives.	The overarching the from this research was the severyone must "understand over the severyone must "understand over the severy one systems". In paction of the severe	Strengths: Purposively self sample; use of a framework to analyse data Limitations: Da relate to propo service model i 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 implement ation of SMRs did not match the internation of providing paties with a holistic review and shared decision- making. The author didentified an important opportunity cost of SMR	Strengths: base detailed, in-dep interviews Limitations: Au note interviews to be complem by data on actu
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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, teding refining for uses related to te elated to te te tenseignement s	practice and longer term follow-up
2020[15]	time series 43 general practices covering 235,595 people in Salford, Greater Manchester	practice in England	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-	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% Cl 20.3% to 36.8%, $p <$ 0.001) at 24 weeks and by 40.7% (95% Cl 29.1% to 54.2%, $p <$ 0.001) at 12 months after introduction of SMASH. The rate of inadequate blood-test monitoring (composite of 2	associated with associated with associated with associated with a social of the potentially hazer for a sprescribing and the practices. This is duction was sustained over 2 months for prescribing but not for monitoring in a marked reduction. The was a marked reduction in rates of hazardous prescribing between practices. The sprescribing between practic	noted pragmatic design, evaluation of clinically relevant outcomes and large number of practices taking part Limitations: Not a randomised study s 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	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%, $p =$ 0.046) at 24 weeks; the change at 12 months (23.5%) was no longer significant (95% CI –4.5% to 61.6%, $p = 0.127$). 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	The PINCER interest 2024. Down cluding for uses related to the second se	Strengths: Sugg intervention wa implemented successfully in routine practice was associated significant redu- in hazardous prescribing
	patients			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	bleeding. These findings support the wider national follout of PINCER in England. Bibliog	Limitations: The authors adjuste calendar time at practice, but since this was at observational st the findings may have been influe by unknown confounding fac or behavioural changes unrelat

				BMJ Open	njopen-2023-081 by copyright, in	
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 (<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.	1934 on 7 August 2024. Downloaded and Strategy S	the PINCER intervention. Data were also not collected for all practices at 6 and 1 months post- intervention Strengths: Pragmat randomised design Limitations: Sample smaller than planned; high loss t follow-up; MRP analysis only covere patients who attended 3 appointments

2				BMJ Open	mjopen-2023-08 by copyright, ir	
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 ($p = 0.032$). 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 \geq 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.	Cluding for uses related to text and Enseignement Superied to text and S	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
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 or

620 patients (aged over 65 years and prescribed ≥ 4 medications)	service. Patients were invited to participate in the service by the community pharmacy team. The pharmacist held regular consultations with the patient and discussed	BMJ Open 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.	mjopen-2023-08 1934 on 7 August 2024. Downloaded from http:// Enseignement Superieur (ABES) . quality of life. equality of life.	validated out measures Limitations: N control/comp group; author some patients probably revis independentl their GP durir study period; relatively high attrition rate
	neld regular consultations with the patient and discussed risk of falls, pain management, adherence and general health. They also reviewed the patient's medication	and quality of life. Cost per quality-adjusted life year estimates ranged from£11 885 to £32 466 depending on the assumptions made.	sed from http://bmjopen.bmj.com/ on June rieur (ABES) . nd data mining, Al training, and similar tec	study period; relatively high attrition rate
	using STOPP/START criteria. Data were analysed for the first 6 months of participation in the service.		12, 2025 at Agence Bibli	

72 Appendix Ta	able 2: TIDieR Lite for UK pł	BM narmacist studies	J Open	by copyright, includir	njopen-2023-081934 c	
Interventio name and study ID(s)	n By whom	What	Where	Intensity	on 7 August 20	How often
CHIPPS Alharthi 2023[18]; B 2021[21]; L 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, care home, care home, medication 	Participating care homes	PIPs committed a medient superiour (ABES) . hours/month to delige superiour (ABES) . Each PIP provided caxt and data mining, Al training, and similar technologies.	The service. approximately bounded from http://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliog	PIPs visited car homes weekly 6 months

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		supplying community pharmacy and study team		1934 on 7 / ncluding 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 are different with the respective CCG Locate harmacist Manager and influence by a number of factors such as engagement from GP practices; primary corrections of the practices; primary corrections of the prescribing support in the prescribing support in the prescribing support in the prescribing support in the prescribing support in the prescribing support in the prescription of the p	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 decision- making) 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 intervention of reported. Prescribing decision could be made by pharmacists alone of in conjunction with GPs g, and similar technologies. Bibliograp	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.		icluding for uses rela	1934 on 7 August 20 Enseigr	
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 ready Midlands, time spend delivering the interverse of the local Medicine of the local Medicine of the local Medicine of the am	Per Dut in the East Dopharmacists windowsourcing level sourcing level timisation (ABES)	Data collected quarterly up t months after starting the intervention[:

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		reviewing patients			
		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		934 on 7 August 2024. Downloaded from http://bm Enseignement Superieur (ABES) . luding for uses related to text and data mining, Al	
Eclipse Live De (electronic co medicines So optimisation av system st (EMOS)) do pr Jeffries pa 2017[13] th	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 (qualitation, bmj.com/ on June 12, 2025 at Agence Bibliogra	Not reported (qualitative study)

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		Patients can access the system through a "Patient Passport"		934 on cluding	
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 terms artile range, 5.0–15.2) times per man the during the first quarter of the towards regular but the sorrequent (median of 5.5 [3.5–97.9] times per month) checks to identify and resolve new cases. The frequent of dashboard use was higher in practices with a larger number of at-risk paris of the source of the source of the source of the source of the source of the source of the source of the source	Dashboard w updated daily Frequency of varied by pra and over time previous colu
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 lease 30 minutes to allow time for shares decision-making technologie 20 20 25 at	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 further appointments available at 2 and 4 months building on patient progress towards agreed goals	Once per pati (up to three appointment

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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 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 Attaining the second data mitring the second data mi	
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Collaborative pharmacist review Thayer 2021[23]	ommunity and becialist mental health harmacists	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	Care homes for people with intellectual disabilities	507 interventions/redigents reviewing for uses related to text and data mining, Al training, and similar technologies.	Once

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		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		1934 on 7 August 2024. Down Enseignement Su cluding 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 estimated at 25 minutes for initial condition, 10 minutes for monthly reading wand 11 minutes for quarter billion, 10 Al training, and similar technologies.	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.
		For peer review only - http://bmjope	n.bmj.com/site/	about/guidelines.xhtml	



MMAT quality assessment results

ИМАТ qualit	y assessment results	BM.	J Open J Open-2023-081934
Reference	Screening questions	Type of study	MMAT questions and answers
Albarthi	S1 Are there clear research	Qualitative	1.1. Is the qualitative approach an $\frac{1}{2}$
2022[12]	$31. Are there theat research an estimate V_{PS}$		α_{μ} and α_{μ
2023[10]	questions: 753		1.2 Are the qualitative data collective methods adequate to address the
			1.2. Are the qualitative data cone in the first state of a solution $\frac{1}{2}$
	52. Do the collected data allow		1.2. Are the findings adequately derived from the data? Vac
	sz. Do the collected data allow		1.5. Are the interpretation of results we will be used in the used
	to address the research		1.4. Is the interpretation of results and clently substantiated by data? res
	questionseres	6	analysis and interpretation? Ves (a properted by use of Theoretical Demains
Alvoc	S1 Are there clear recearch	Quantitativo non	P(u)(ework) $w > 3$
AIVES	SI. Are there clear research	Qualititative non-	bomo residents)
2019[19]	questions? res	ranuomiseu	2.2 Are measurements appropriate reparding both the outcome and
			5.2. Are measurements appropriate regarding both the outcome and
	52 Do the collected data allow		2.2 Are there complete outcome anter Cap't tell (partial data presented)
	sz. Do the collected data allow		3.4. Are the confounders accounted for in the design and analysis? No
	to address the research		(uncontrolled before (offer study) a
	questions? res		Concontrolled before/after study) a
			3.5. During the study period, is the intervention administered (or exposure
Denin	C1. And the new place was a wash	Our antitations as a	2.4. Are the next since the next second of the terrest next letter 2 Ver (second
Badir	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes (care
2017[20]	questions? res	randomised	nome residents)
			3.2. Are measurements appropriate regarding both the outcome and
	C2. Do the collected data allow		Intervention (or exposure)? Yes o B
	S2. Do the collected data allow		3.3. Are there complete outcome gatar res (all specified outcomes
	to address the research		reported)
	questions? res		5.4. Are the contounders accounted for in the design and analysis? No
			2.5 During the study period is the intervention administered for surgery
			3.5. During the study period, is the intervention administered (or exposure
			raphiq
			lue
	For poor	review only - http://hmiopo	n hmi com/site/about/quidelines yhtml
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				right, in
	Birt 2021[21]	S1. Are there clear research	Mixed methods	5.1. Is there an adequate rational \mathcal{E} for \mathcal{B} using a mixed methods design t
		questions? Yes		address the research question? Y_{e} (qualitative and quantitative data
				relevant to process evaluation) $\frac{2}{5}$
				5.2. Are the different component of 播e study effectively integrated
		S2. Do the collected data allow		answer the research question? Yes and constraints and discussion
		to address the research		5.3. Are the outputs of the integration of qualitative and quantitative
		questions? Yes		components adequately interpret
				5.4. Are divergences and inconsister des between quantitative and
				qualitative results adequately addressed? Yes (page 11 column 2)
				5.5. Do the different components 🍯 🛱 👼 study adhere to the quality
				criteria of each tradition of the metrodified involved? Yes
	Howard	S1. Are there clear research	Quantitative	4.1. Is the sampling strategy relevert to address the research question
	2014[11]	questions? Yes	descriptive	Yes
				4.2. Is the sample representative 函前 arget 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 biaន្ល្លloឆ្នី? Yes (data from intervention ar
		questions? Yes		only) <u> </u>
				4.5. Is the statistical analysis approprigte to answer the research
				question? Yes
	Jeffries	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach approa
	2017[13]	questions? Yes		question? Yes (explored factors perceiged to affect adoption and
				implementation)
				1.2. Are the qualitative data collegionemethods adequate to address t
		S2. Do the collected data allow		research question? Yes (interview and focus groups)
		to address the research		1.3. Are the findings adequately derived from the data? Yes (context-
		questions? Yes		mechanism-outcome groups identធ្វីedប្លឹ
				1.4. Is the interpretation of results sufficiently substantiated by data?
				1.5. Is there coherence between quality ative data sources, collection,
_				analysis and interpretation? Yes (supparted by use of realist analysis)
	Jeffries	S1. Are there clear research	Qualitative	1.1. Is the qualitative approach apprograte to answer the research
	2018[12]	questions? Yes		question? Yes (explored factors perceized to affect adoption and
				implementation)

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	S2. Do the collected data allow to address the research questions? <i>Yes</i>		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)
Lane 2020[22]	S1. Are there clear research questions? YesS2. 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 above 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 derived from the data? Yes 1.4. Is the interpretation of result sufficiently substantiated by data? Yes (supported by relevant quotes) 1.5. Is there coherence between chaling it was and interpretation? Yes (Figure 1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.
Madden 2022[14]	S1. Are there clear research questions? <i>Yes</i> S2. Do the collected data allow to address the research questions? <i>Yes</i>	Qualitative	Framework) Image: State of the state
Peek 2020[15]	S1. Are there clear research questions? <i>Yes</i>	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 Gor intervention)

		נואום	copyri
		_	ght, in
	S2. Do the collected data allow		3.3. Are there complete outcome attag Yes
	to address the research		3.4. Are the confounders account 🛱 for in the design and analysis? N
	questions? Yes		(small risk of unmeasured confounឱ្យingរី
			3.5. During the study period, is the intervention administered (or exp
			occurred) as intended? Can't tell (ខ្លាំដូឌីក្លុentions not externally validate
Rodgers	S1. Are there clear research	Quantitative non-	3.1. Are the participants represen a we of the target population? Yes
2022[16]	questions? Yes	randomised	(general practices and their patien辭長 羟
			3.2. Are measurements appropria विक्रुं egarding both the outcome and
			intervention (or exposure)? Can't eff gor intervention)
	S2. Do the collected data allow		3.3. Are there complete outcome ត្ថិដ្ឋភ្ល្ល៊ី No (6- and 12-month data no
	to address the research	6	collected from all practices) and the de
	questions? Yes		3.4. Are the confounders account क्युनिक्रें in the design and analysis? N
			(small risk of unmeasured confounម្នាំរក្ខារី
			3.5. During the study period, is th를i쨼멸rvention administered (or exp
			occurred) as intended? Can't tell (ate gentions not externally validate
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 a base line? Yes
			2.3. Are there complete outcome gata 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? Cal
	questions? Yes		tell (outcome data from GP electronic records)
			2.5 Did the participants adhere to the assigned intervention? No (30%
			to follow-up or withdrew)
Inayer	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population? Yes
2021[23]	questions? res	randomised	nome residents with intellectual disable les)
			3.2. Are measurements appropriate regarding both the outcome and
	52 Do the collected data allow		
	to address the research		33 Are there complete outcome dat 2 Ves (all specified outcomes
	auastions? Ves		renorted)
	questions: 103		$\vec{\sigma}$
			(uncontrolled hefore/after study)

		В	MJ Open MJ Open - 2023-0;	
			<u> </u>	lor exposure
			occurred) as intended? Yes (one-off review mainly based on rec	ords)
Twigg	S1. Are there clear research	Quantitative non-	3.1. Are the participants representative of the target population	on? Can't tell
2015[24]	questions? Yes	randomised	(no indication of attempts to recruit a Representative sample)	
			3.2. Are measurements appropria 🖉 🖽 🛱 arding both the outcon	ne and
			intervention (or exposure)? Yes (de Bis recorded for intervention	วท
	S2. Do the collected data allow		components and associated outco 🖓 👼 🔀	
	to address the research		3.3. Are there complete outcome द्विन्द्वेक्ट Can't tell (limited respo	onse for
	questions? Yes		resource use outcomes)	
			3.4. Are the confounders accounted or in the design and analy	/sis? No
		6	(uncontrolled before/after study) a a b	
			accurred) as intended? Can't tell (argent 20% withdrawal rate)	lor exposure
			tp://bmjopen.bmj.com/ on June 12, 2025 at Agence Bibliographique c). Al training, and similar technologies.	
	For peer	review only - http://bmjo	pen.bmj.com/site/about/guidelines.xhtml	

PRISMA 2020 Checklist

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1 2	PRISM	PRISMA 2020 Checklist		
3 4 5	Section and Topic	ltem #	Checklist item	Location where item is reported
6	TITLE			
7	Title	1	Identify the report as a systematic review.	Title
8	ABSTRACT	I		
9 10	Abstract	2	See the PRISMA 2020 for Abstracts checklist.	p2
10	INTRODUCTION			
12 13	Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction (pp4-5)
14	Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Methods (p6)
15	METHODS			
16	Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Methods (p6)
17 18	Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consuled to the date when each source was last searched or consulted.	Methods (p7)
19 20 21 22 23 24 25	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 may regiewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation to logical 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)
20 27 28	Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which gesuits to collect.	Methods (pp7- 8)
29 30		10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, tinding sources). Describe any assumptions made about any missing or unclear information.	Methods (pp7- 8)
31 32	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)
33 34	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)
35 36	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)
37 38		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
39 40		13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	N/A (summary tables only)
41 42		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 a	N/A
43 11		13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analy 🖣 s, meta-regression).	Methods (p8)
44 45		13f	Describe any sensitivity analyzes conducted to assess projectives biof thers / sites is a conducted to assess projectives biof thers / sites is a conducted to assess projectives biof thers / sites is a conducted by a	N/A
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PRISMA 2020 Checklist

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PRIS	MA 20	D20 Checklist	
Section and Topic	ltem #	Checklist item	Location where item is reported
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Results (p8)
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the bar and selection process, from the number of records identified in the search to the bar and selection process.	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.	Supplementary 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.	Supplementary table
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) a structured and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Tables 1-4 where available and appropriate
Results of	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Results (p22)
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 gire ation 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 as esed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Results (p22)
DISCUSSION		02 202	
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Discussion (especially p27)
	23b	Discuss any limitations of the evidence included in the review.	Discussion (especially 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

PRISMA 2020 Checklist

Pag	ge 73 of 72		BMJ Open	cted k	36/bm	
1 2	PRISMA 2020 Checklist			y copyrigh	Jopen-2023	
3 4 5	Section and Topic	Section and Item Fopic # Checklist item		:, incluc	-081934	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 9	Title page
7		24c	Describe and explain any amendments to information provided at registration or in the protocol.	for	N Þ	P9
0 9	Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or spons	sors in the	eview.	Title page
10 11	Competing interests	26	Declare any competing interests of review authors.	as rela	ust 202	Title page
12 13	Availability of data, code and	27	Report which of the following are publicly available and where they can be found: template data collectic studies; data used for all analyses; analytic code; any other materials used in the review.	on formation	data extracted from included	Data sharing statement
14						(p30)
16	From: Page M.L.M	IcKenzie .IE I	Bossuvt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an undated guideline for reporting	systemati	noviews BMJ 2021:372:n71 doi:	10 1136/bmi n71
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