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The role of informal carers in medication management for people with long-term conditions; A systematic review

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The role of informal carers in medication management for people with longterm conditions; A systematic review

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Abstract

Objectives: To explore the literature about the role of unpaid informal carers such as family members and friends in medication management for people with long-term conditions.

Design: Systematic review designed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Information source: MEDLINE (Ovid), Embase (Ovid), PsycINFO, CINAHL (EBSCO), Scopus, and Web of Science were searched from inception until April 2024. Additional papers were identified by searching backwards and forwards the reference lists of included papers.

Eligibility criteria: Primary research studies were included if they reported medication-related activities undertaken by carers for people with long-term conditions. Qualitative and mixed methods studies were considered without restriction on language or country.

Data extraction and synthesis: Relevant data were extracted and summarised in a table. The Mixed Method Appraisal Tool was used for quality assessment. Data were narratively synthesised.

Results: From 12473 identified records, 107 underwent full text screening and 20 studies were included. Family carers were the predominant type of carer. Spouses and adult children constituted the largest caregiving dyads. Based on the required skills two groups of roles were identified; physical roles, such as prescription management, and cognitive roles such as decision-making. Carers used different strategies and tools to undertake medication-related activities including compliance aids and alarms. However, carers reported challenges in their experiences of caregiving, flagging up their need for additional support and education to commence such activities.

Conclusion: Informal carers undertake a wide variety of medication-related activities. The studies emphasised the need to support families as partners in health outcomes. This systematic review identifies the importance of bridging the gap between carers and health care providers. More efforts are needed to empower carers towards better and safer caregiving. Future work could address how to optimise carer involvement and engagement and provide best practice recommendations for carers support.

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PROSPERO registration number CRD42024506694.

Strengths and limitations of this study

- To our knowledge, this is the first systematic review investigating the role of informal carers in medication management for people with long-term conditions.
- This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA) guidelines.
- To identify relevant literature, broad inclusion criteria were adopted.
- sible to p. It was not possible to perform a meta-synthesis due to the heterogeneity in several aspects.

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Introduction

The increase in long-term conditions (LTCs) among the population poses challenges to the health and social care system causing increasing morbidity, mortality and economic burden [1,2]. Alongside the rise in LTCs, there is increasing concern about the concurrent intake of multiple medications per person [3–5]. Previous research has highlighted the likelihood of medication management complexity for people with LTCs [6]. Up to 50% of people with LTCs do not take their medications as prescribed leading to adherence problems [7]. In addition, there is a higher probability of medication related problems including drug-drug interactions, side effects, and medication misuse [3–5]. People with LTCs often require co-management and support with medication use, which can be offered by informal carers [8,9].

An informal carer is an umbrella term used to describe "anyone who looks after a family member, partner or friend who needs help because of their illness, frailty, disability, a mental health problem or an addiction and cannot cope without their support. The care they give is unpaid" [10,p.9]. In 2021,the United Kingdom (UK) carers' input was estimated to be worth £162 billion annually, which is equivalent to the National Health Service (NHS) annual expenses in England and Wales [11].

People with LTCs frequently receive support from carers alongside health care providers as part of a "care triads" [12–15]. People with LTCs and their carers are more likely to require pharmacy services accessibility and continuous dealing with medications [16]. Pharmaceutical care services help carers to mitigate the stress associated with their medication management tasks [17]. The caregiving role can vary from basic daily assistance with bathing, eating or dressing to more complex medical tasks such as administering injections [18]. According to a scoping review, there is a large number of studies conducted on the informal caregiving experience of older adults with a single chronic condition [19]. The literature has typically focused on specific or broad disease states such as cancer, dementia and palliative care [20,21]. However, there is a paucity of studies investigating this topic within LTCs [19].

Less attention has been paid to the carers of people with LTCs; the carer role has been underestimated and carer's need for support is not well understood [22]. There is, however, no systematic review that explores the role of carers amongst people with LTCs. Therefore, this review was conducted to answer the following question: what is the role of informal carers in medication management activities?

Methods

Design

This systematic review is reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA) guidelines (see **Supplemental material**) [23].

Search strategy

The following databases were searched from inception until April 2024: MEDLINE (Ovid), Embase (Ovid), PsycINFO, CINAHL (EBSCO), Scopus, and Web of Science. The terms used in the search strategy were related to medication management, informal carers, and long-term conditions (see **Supplemental material**). The search strategy was modified to each database to suit its indexing structure, syntaxes, and subject headings. Reference lists of all included papers were screened backwards and forwards to identify additional papers.

Study selection

Inclusion criteria for studies were determined in line with SPIDER (Sample, Phenomenon of Interest, Design, Evaluation, Research type) tool (see **Table 1**). Initial screening of titles and abstracts was completed by the primary researcher (MA) and checked by (CR and LL). Full-text studies were screened and reviewed independently by at least two members of the research team (MA, CR and LL) using the same criteria. Disagreements were solved through discussion. Studies that did not fulfil the inclusion criteria were excluded.

Criteria	Inclusion	Exclusion
S- Sample	• Adult living in the community with one or more long-term conditions.	 Papers focused on: People below 18 years. People in settings where they receive additional assistance with their medication (in-patients or nursing homes, home carers, Macmillan, or hospice at home care. People at the immediate end of life. People with acute illness or injury.
P&I- Phenomenon of interest	 Medication management activities provided by an adult informal carer or equivalent. 	 Papers focused on: Paid carers only. Young carers below 18 years old. Unspecified age of young carers.
D-Design	 Primary peer reviewed papers. From inception until April 2024. Any language. 	 Systematic reviews, literature reviews and realistic reviews.

Table 1: SPIDER criteria

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	Any country.	 Conference abstract, editorial, book chapter, report papers, leaflets, meeting notes and dissertations. Not available as full-text papers.
E-Evaluation	 Carers activities in medication management including care- recipients, carers and health care providers experience of carer role; care-recipient and/or carer outcomes, and the nature of carer-recipient dyads. 	N/A
R- Study	Qualitative and mixed method	No qualitative data.
design	studies.	

Data extraction and evaluation

Data were extracted and summarised by (MA) using a standardised data extraction form (see **Supplemental material**). The Mixed Methods Appraisal Tool (MMAT) was used to appraise qualitative and mixed methods studies [24]. Quality assessment was completed by (MA) independently and supervised by (CR and LL). Disagreements were solved through discussion.

Data synthesis

Narrative synthesis was used to present findings in three steps [25]. Firstly, developing a preliminary synthesis of the findings of the included studies. This step was conducted by constructing a descriptive summary of the included studies by tabulating studies' details and identifying types of provided activities. Secondly, exploring relationships within and between studies by categorising and structuring into themes based on the carer activities. Thirdly, assessing the generalisability of the studies to draw a conclusion based on this synthesis.

Results

Data extraction and evaluation

The search identified total *12,473* articles; an additional 13 articles were identified through manual searching. After removing duplicate records, *5947* studies were screened. One hundred and seven articles were eligible for full-text screening. A total of 20 studies were included in the review (see **Figure 1**).

Of the 20 included studies, two used mixed methods [26,27] and four were sub-studies, conducted as a part of larger studies [28–31]. Three studies were published before 2010

[26,27,32], seven were published between 2020–2024 [28,31,33–37], with most published between 2010-2019 [29,30,38–45].

According to the World Bank classification of countries by the World health organisation [46]. Most of the studies were conducted in high-income areas [26–30,32,33,35–45]. The UK [26,27,32,33,35,37,39,42,44,45], Canada [38,40,43], the United States [28,30,41], Germany [29], and Switzerland [36]. Another study was conducted in China, a country classified as uppermiddle-income [34] and one in Malawi, a low-income country [31].

According to MMAT tool, all studies apart from two ranked as a high quality based on the qualitative criteria of assessment [26–28,31–45]. The two studies rates as medium were substudies and there was a lack of clarity regarding how the data were collected relative to the original study [29,30]. No studies were excluded based on the quality assessment.

Carers demographics and challenges

Carers helped both family and non-family members. Carer-recipient dyads were predominantly familial [26–45]. Primarily including spouses [26–28,30–34,36–39,41,43–45], adult children [26–28,30,32,33,36–39,41,44,45], relatives [26,27,29], siblings [30,32,37], adult grandchildren [27,30,38], and parents [43]. Support was also provided by friends [26–29,35,37,38,40] and neighbours [26,27,37,38,40].

In term of care-recipients, nine studies were conducted on older adults with polypharmacy [26–28,32,33,35,36,38,41]. Eleven studies focused on investigating specific conditions including chronic obstructive pulmonary disease [39], dementia [40,42,44,45], glaucoma [44], heart failure [30], human immunodeficiency virus [31], inflammatory arthritis [43], Parkinson disease [37], and type II diabetes [29,34].

Carers prioritised care-recipients health over their own needs [32,34,38–40,42]. Some studies reported that carers and care-recipients held contrasting beliefs about medication effectiveness and need which complicated medication use and management [26,32,36,39,45]. Where carers had poor skills in handling medications this resulted in safety concerns [32,34,38,40].

Carers frequently experienced difficulty in accessing health care providers and services [32,33,35,37,42,45]. They were critical about the limited consultation timeframe which made it challenging to ask questions [38,42,43,45]. There were some concerns about the exclusion of care-recipients from the conversation during consultations when the carer attended [45]. Sometimes, carers were not informed about prescription changes, either due to absence or exclusion from consultations [45]. Challenges were more likely to occur when new medications were added [33,36,40,45]. It was reported that poor relationships with health care providers resulted in difficult medication management [26,30,33].

Medication management roles

A wide range of medication management roles and related activities were offered by carers across the included studies (see **Figure 2**). Depending on the skills required, the roles carers were involved in could be considered either cognitive or physical [41].

Carers involvement in medication management was varied and highlighted as an obligation [32,36,38,42]. Carers pointed out that their role in medication management had evolved from 'obligation' to 'automatism' and 'habit' [36]. The involvement of carers was varied, ranging from participation in some activities to taking full responsibility for medication management [26,27,32–35,38–41,45]. Care-recipients often requested carers assistance regardless of their physical and cognitive capabilities [32,36,44]. Respecting care-recipients autonomy and independence was valued by carers, leading to partial or no involvement of carers [28].

Physical roles

Prescription management

In 12 studies, prescription management was reported [26,27,31–33,35,37–39,41,42,45]. This role involved several activities, including ordering [26,27,32,35,37–39,41,42,45], collecting [26,27,31,32,35,37–39,41,42,45], buying over-the-counter medications [26,27,35], maintaining adequate stock [26,27,33,35,38,39,42,45], and purchasing equipment for prescribed medications[27,39] such as nebulisers parts [39].

Carers reported difficulties navigating ordering systems or procedures [26,27,32,45]. Also, carers hassled with managing medication supplies [26,33,35,39,42]. Keeping track of supplies was challenging in certain circumstances such as running out of stock during the weekend [42], post-discharge [33] or the COVID-19 pandemic [35], and obtaining medications from multiple locations [35].

Preparation, organisation and administration

Carers contributed to medication preparation and organisation in 15 studies [26–30,32,33,36–42,45]. Carers used pill-boxes to arrange medications[27,28,30,36,38,40–42,45]. Pill-boxes were filled away from the care-recipient for higher accuracy [30]. Carers complained about the slot size and space [41]. Conversely, some carers acknowledged the usefulness of pill boxes in tracking and receiving the correct medication [42,45]. However, more concern were raised about errors and mistakes [45].

Carers used other types of containers to organise medications such as coloured box lids [36], coloured coded jars [27], plates [27,38,41], glasses [27,41], pots [32,33], and ordered bottles per dose[28]. When necessary, carers prepared doses in advance by setting inhalers [38], opening containers [26,27,37,38], dissolving [37,40], diluting [39], splitting [27,41], and crushing [40]

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doses. Beyond preparing doses, carers took responsibility for cleaning and maintaining nebulisers [39].

Carers participated in medication administration across 15 studies [26–30,32,36,38–45]. Carerecipients received assistance with several pharmaceutical formulations or devices [26-30,32,36,38–45] (see Table 2). Carers reported challenges with the lengthy process of nebuliserrelated activities and possible technical problems [39]. Dealing with different inhaler devices caused problematic experiences [39]. It was challenging for carers to provide frequent support throughout the day [26]. Also, it was confusing to prepare and provide multiple medications with similar characteristics, such as being a white colour [30,41]. Carers used strategies to address these issues by writing indications or strengths on the bottles [41]. Frequent dosing was flagged in other included studies as a broader challenge in medication management [27,30,37,39,40,42].

Table 2: Pharmaceutical formulations handled by carers. This data were extrapolated from the included studies via main text, quotes or examples.

				Pharma	aceutical fo	rmulation	S	-	
Authors	Ear drops	drops	Inhalers	Injections	Nasal spray	Nebulisers	Oral	Sublingual	Topical
Alhaddad <i>et</i> <i>al</i> .(2016) [39]				C		✓			
Bernhard <i>et</i> <i>al</i> .(2017) [29]				~	R		~		
Bieri <i>et al.</i> (2021)[36]					1		~		
Conor <i>et al.</i> (2021) [28]						0	~		
Francis <i>et al.</i> (2002)[27]	✓	✓	~	~		2	~		✓
Goldstein <i>et</i> <i>al</i> .(1996) [32]		✓					V		
Kaasalainen <i>et al</i> .(2011) [40]							✓		
Lang <i>et</i> <i>al.</i> (2015)[38]							•		
Look <i>et al.</i> (2018)[41]		√	~	\checkmark	~	~	~		
Maidment <i>et al.</i> (2017) [42]							~		

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Mickelson et					✓	✓	✓
<i>al.</i> (2018) [30]							
Rai <i>et al.</i>			✓				
(2018) [43]							
Read et al.	\checkmark				\checkmark		
(2018) [44]							
Smith <i>et al</i> .		✓			\checkmark		\checkmark
(2003)[26]							
Smith et al.					\checkmark		
(2015) [45]							

Storge

The practice of storing medications by carers was reported in three studies [32,38,41]. Storing medications in multiple places impacted care-recipient safety and adherence [38]. For example, in one study care-recipients experienced difficulties finding medications that were lost between cupboards [38]. Carers stored the medications away from care-recipients to minimise the risk of medication errors, especially for people with dementia [32,41]. Large quantities of medication were kept in a lockbox [38,41].

Cognitive roles

Reminding

Fourteen studies reported the role of carers in reminding care-recipients to take their medication regularly [26,27,41,43–45,28,31–34,36,37,40]. Different strategies were used to facilitate this role (see **Supplemental material**). Carers expressed concern about the care-recipient's dependency on carers to provide frequent dose reminders [44]. Reminding strategies were used either to remind carers themselves or care recipients [41]. Routine markers including placing notes or medication in visible places or linking doses to daily routines were frequently used [26–28,32,36,41,44]. However, routine markers were not effective for some care-recipients, especially for those with memory issues or where notes were disregarded by care-recipients [41,44].

Monitoring and tracking of medications

Tracking and monitoring health conditions and/or medications was cited across 15 studies [26–30,32,34,36–41,44,45]. This entailed side effects monitoring [26,27,32,36,39,41,45], tracking medication intake [28,30,37,40,41,44,45], and checking prescriptions is correct [26,37]. Carers created or used printed a medication list to track medication-related information and activities or guide care-recipients [29,30,38,41]. Carers raised some concerns about side effects and medication tolerance [32,36,39,45]. As a result of monitoring and tracking, carers were able to detect potential side effects before health care providers did [41]. The results in two studies showed that carers also undertook disease parameters monitoring such as monitoring

biochemical readings and markers e.g. coagulation and glucose, and other health monitoring [34,41].

Carers needing medication-related information for decision-making

Carers were involved in obtaining and/or sharing medication-related information in 15 studies [26,27,29–33,35–39,41,42,45]. Carers searched for information relating to medications or disease management from varied sources including general practices [39,45], other health care providers [26,27,32,33,35–37,41,42,45], the internet [33,37,38,41,45], libraries [37,41], medicine leaflets [26,27,33,36,39,45], prescription printouts [41], magazines [45], local support groups [37], charities [37], and manufacturing manuals [39]. Other family members with medication experience were consulted for information [29,37–39]. As in other carers, peers acted as a source to exchange information and experiences [29].

For carers, it was important to get the right information and to understand the instructions [42]. Carers struggled to understand the patient information leaflet in two studies [26,45], but were keen to read prescription instructions and medication names carefully in order to avoid potential errors [37]. Furthermore it was reported that health care providers gave incomplete or unclear instructions [39]. The risk of poor medication labelling, inadequate documentation, and not having user-friendly documents was a source of carers frustration [26,38]. Several carers reported lacking knowledge and understanding of medication-related information [26,30,32–39,42,45]. Carers emphasised their need for more information about the indication [26,45], frequency [39,45], and side effects [26,32,39,45] of medications. Particularly information about new medications was a critical need for carers [33,36,40,45].

In eight studies, carers debated the risks and benefits of the care-recipient's medications [26,27,30,37,39,41,42,45]. Suggestions by carers to change medications were varied and included initiating [27,39], adjusting [26,27,30,37,39,41,42], and stopping medication [26,30,39,45]. Changes in dose timing were made by carers in response to their own commitments and care-recipients needs [26,27].

Carers required medication-related information to monitor care-recipients and coordinate care with health care providers [41], and influence care-recipient adherence [27]. In particular, carers shared information with care-recipients [26,27,29,31,38,45] and health care providers [30,32,41]. A lack of medication-related information was associated with difficulty in decision-making [32,39,45]. Health care providers had commented on the importance of carers and care-recipients education to promote adherence [40]. Similarly, care-recipients suggested educating family members about their medications [43].

Discussion

To our knowledge, this is the first systematic review that aimed to explore the role of carers in medication management for people with LTCs. This review highlights the diversity of carer roles and activities related to medication management and highlights the need to recognise carers are having expertise in the patient's lived experience.

Carers support people with LTCs with cognitive and/or physical elements of medication management. Physical roles include (i) prescription management, (ii) preparation, organisation and administration, (iii) storage and cognitive roles include (i) reminding, (ii) monitoring and tracking of medications, (iii) medication-related information and decision-making. In the studies, carers took an integral and multi-faceted role ranging from basic physical assistance to independent decision-making and it is likely that the identified activities were interlinked. For example, monitoring for disease symptoms corresponds to administrating medications and further actions. Carers involvement was varied owing to changes in the care-recipients medications, conditions and needs.

Familial caregiving was the predominant type of carer-recipient dyad across the included studies. The findings of this review support the work of Manias *et al.* (2019), who reported the role of family carers in managing medication complexity and participating in decision-making [47]. This work, however, only focused on elderly people across transitions of care [47]. In our review, there was a range of dyads included but there was no noticeable difference between the dyads in the nature of the medication management activities carers were involved in.

Caring for people with LTCs was often associated with complexity. This experience can be explained by the lack of supportive resources while dealing with (i) multiple medications, (ii) different needs, and (iii) frequent activities. Given that carers involvement appears to be key in the medication management process, our findings suggest the need to better support carers for people with LTCs. According to the reviewed evidence, a systematic approach to support carers was lacking. Fragmentation was captured between carers and health care providers in terms of communication, education, and training. Although carers are involved in several medicationrelated activities, they do not receive structured training or education in this area. Carers have created their own strategies for medication management and modifying the available tools. This also aligns with previous findings, which showed that carers tend to discover undertaking their responsibilities by trial and error [48]. Of a particular concern, is that most carers are not able to establish communication and partnerships with health care providers to fulfil their needs. A similar position was offered by Gillespie et al. (2014), who emphasised that lack of information, training, and poor relationship with health care providers were the most common factors that negatively affect carers experiences [49]. Similarly, Pu et al. (2023), reported the failure of carers to be actively involved in pain management for people living with dementia due to the same

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factors [50]. Lawson *et al.* (2022), highlighted the need to support carers with information and training to mitigate caregiving burdens [51]. In the context of care transition and discharge planning, similar needs were flagged by carers [47,52].

Most of the studies included in this review indicate that carers were not actively involved with health care providers. More actions are needed to empower carers in medication management role. This should entail involving carers in consultations and decision making alongside care-recipients and health care providers. Along the same lines, Eriksen *et al.*(2020) recommended that health care providers need to escalate efforts in communicating and involving social networks in medication-related experiences for people with polypharmacy [53]. Pharmacies are one place recognised to have potential for better supporting carers [54]. Furthermore, familiarising carers with prescription management activities and processes. Medication management tools and strategies were anticipated to facilitate carer roles. However, different perspectives and attitudes were noted regarding using compliance aid and reminder strategies across the included studies. Therefore, better evidenced tools and strategies could be designed with carers in mind as the end users.

This review was conducted according to PRISMA guidelines to ensure the required level of rigor and transparency. Broad inclusion criteria were used to allow identifying and inclusion of relevant literature with no restrictions to language and country. Studies that were not specifically designed to explore carers medication-related activities but did report some relevant data were included and as such it was not possible to perform a meta-synthesis. The reason for this is threefold: (i) the heterogeneity of included studies, (ii) the range and variety of medicationrelated activities and (iii) the variation in care-recipients' conditions. In this review, most of the evidence is from Europe, and UK constitute 50% of the papers which might limit the generalisability of the findings to high income countries. Overall, no evidence was found about care-recipients outcomes. Also, obtaining and sharing information activities tended to be incorporated as part of care-recipient disease management information. Therefore, it was difficult to identify discrete information about medicationrelated information across some studies.

This review contributes to knowledge around understanding the current roles and needs of carers and people with LTCs around medication management. Further work is needed to evaluate carers lived experiences in undertaking medication management roles and related activities. A preliminary step towards identifying supportive mechanisms for carers is to appreciate carers roles and needs. Carers and health care providers perspective can inspire successful caregiving experiences and better services utilisation. An initiative to establish network channels between carers and health care providers could be discussed.

Conclusion

The results of this review showed that informal carers contribute to the medication management process in the community for people with LTCs. They provide interlinked activities that can require frequent adaptations. Health care providers need a mechanism to better support carers in these activities, outline their involvement and address their needs in their caring role. Hearing carers' voices is vital to developing the best recommendations and guidance for carers' involvement and support to allow them to better provide care in medication management in a safe and effective manner without overburdening the carer.

Footnotes

Author contributions: All authors contributed to the design, development and drafting of this manuscript.

Conflict of interest: No conflict of interest.

Data availability: All data supporting the findings of this systematic review can be found within the main article and/or the supplemental material document.

Ethics: The study was carried out on published papers, and no human participants were involved. Therefore, this research is exempt form ethical approval.

Patient and public involvement: No patient and/or public involvement.

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Figures legend
Figure 1. PRISMA flow diagram.
Figure 2. Medication management roles.





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data mining, AI training, and similar technologies

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The role of informal carers in medication management for people with long-term conditions; A systematic review

Content

- 1- Reminding tools
- 2- PRISMA checklists.
- 3- Study characteristics.
- 4- Data extraction.
- 5- MMAT assessment.
- 6- Search strategies via databases.

Reminding tools

				Remir	nder tools			
Authors	Alarm	Calander/ Checklist	In-person visiting	Notes	Phone call	Phone text	Routine markers	Verbal remindin g
Bieri <i>et al.</i> (2021)	~			~			~	
Conor <i>et al.</i> (2021)	V				✓			~
Francis <i>et al.</i> (2002)	C						~	
Goldstein <i>et al</i> . (1996)							~	
Kaasalainen <i>et</i> <i>al.</i> (2011)				√				
Look <i>et al.</i> (2018)	√	v		~			~	~
Rai <i>et al</i> . (2018)						✓		
Read <i>et al.</i> (2018)		✓			~		✓	~
Ruark <i>et al.</i> (2024)			1	-	N/A	1		
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Tan <i>et al.</i> (2023)	√					2	~	
Tomlinson <i>et al.</i> (2020)		×						
Tu <i>et al</i> . (2021)					N/A			

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PRISMA -Abstract cl	hecklist	n-2024-09444 opyright, incl	
Section and Topic	ltem #	Checklist item	Reported (Yes/No)
TITLE		for Fe	
Title	1	Identify the report as a systematic review.	Yes
BACKGROUND	•	reig reig	
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the ray addresses.	Yes
METHODS		to to	
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	Yes
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify a lies and the date when each was last searched.	Yes
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	Yes
Synthesis of results	6	Specify the methods used to present and synthesise results.	Yes
RESULTS	•	<u>≥</u>	<u> </u>
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.	Yes
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of ingluded studies and participants for each. If meta-analysis was done, report the summary stigate and confidence/credible interval. If comparing groups, indicate the direction on the effect (i.e. which group is favoured).	Yes
DISCUSSION	•		
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the $ar{b}$ eview (e.g. study risk of bias, inconsistency and imprecision).	After the abstract
Interpretation	10	Provide a general interpretation of the results and important implications:	Yes
OTHER	<u> </u>		
Funding	11	Specify the primary source of funding for the review.	N/A
Registration	12	Provide the register name and registration number.	After the abstract
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Section and Topic	Item #	Checklist item	Locatio where i reporte
TITLE	I		
Title	1	Identify the report as a systematic review.	1
ABSTRACT	I	ate	
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTIO	N		
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	4
METHODS	1		
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped the syntheses.	5.
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted to identify studies.	5
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	(Supple mate
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the reversive including how many reviewers screened each record and each report retrieved, whether they worked and each report and if applicable, details of automation tools used in the process.	5-
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 confined independently, investigators, and if applicable, details of automation tools used in the process.	6
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, and if not, the methods used to decide which results to collect.	N/
	10b	List and define all other variables for which data were sought (e.g. participant and intervent Bn characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	(Supple mate

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Section and Topic	ltem #	Checklist item	Location where item is reported
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.	6 (Supplemental material)
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.	N/A
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e. by the planned groups for each synthesis (item #5)).	6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such a bandling of missing summary statistics, or data conversions.	6
	13c	Describe any methods used to tabulate or visually display results of individual studies and theses.	6
	13d	Describe any methods used to synthesize results and provide a rationale for the choice and states analysis was performed, describe the model(s), method(s) to identify the presence and extent of states tical heterogeneity, and software package(s) used.	6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (art in grow reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for a outcome.	N/A
RESULTS	•	gie ie	
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	6
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and graphical why they were excluded.	6
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Section and Topic	ltem #	Checklist item	Location where item is reported
Study characteristics	17	Cite each included study and present its characteristics.	6-7
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	(Supplemental material)
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where by	N/A
Results of	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing tudies.	7
syntheses	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present summary estimate and its precision (e.g. confidence/credible interval) and measures of heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results	N/A
Ī	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synt set	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome sessed.	N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	12-13
	23b	Discuss any limitations of the evidence included in the review.	13
	23c	Discuss any limitations of the review processes used.	13
	23d	Discuss implications of the results for practice, policy, and future research.	13
OTHER INFORM	ATION	yen o	
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	3
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	3

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Section and Topic	ltem #	Checklist item	Location where it reported
	24c	Describe and explain any amendments to information provided at registration or in the grotecol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	14
Competing interests	26	Declare any competing interests of review authors.	14
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found at the following are publicly available and where they can be found: temp of the following are publicly available and where they can be found at the following are publicly available at the following are publicly available at the following at the f	14
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Studies characteristics

#	Authors	Year	Country	Methodology	Study design
1	Alhaddad <i>et al.</i>	2016	UK	Qualitative study	Semi structured interviews
2	Bernhard <i>et al.</i>	2017	Germany	Qualitative sub-study	Focus groups
3	Bieri <i>et al.</i>	2021	Switzerland	Qualitative study	Semi-structured interviews
4	Conor <i>et al.</i>	2021	USA	Qualitative sub-study	Semi-structured interviews
5	Francis <i>et al.</i>	2002	UK	Qualitative study and quantitative analysis	Structured interviews
6	Garfield <i>et al.</i>	2021	UK	Qualitative study	Semi-structured interviews
7	Goldstein <i>et al.</i>	1996	UK	Qualitative study	Unstructured interviews and three group discussion
8	Kaasalainen <i>et al.</i>	2011	Canada	Qualitative study	Grounded theory
9	Lang et al.	2015 📏	Canada	Interpretive description and multiple methods	Semi-structured interviews and focus groups
10	Look <i>et al.</i>	2018	USA	Qualitative study	Focus groups
11	Maidment <i>et al.</i>	2017	UK	Qualitative study	Semi-structured interviews
12	Mickelson <i>et al</i> .	2018	USA	Qualitative sub-study	Interviews
13	Rai <i>et al</i> .	2018	Canada	Qualitative study	Focus group
14	Read <i>et al.</i>	2018	UK	Qualitative study	Semi-structured interviews and ground theory
15	Ruark <i>et al.</i>	2024	Malawi	Mixed-methods observational study- sub-study	In-depth qualitative interviews
16	Smith <i>et al.</i>	2003	UK	Qualitative study and quantitative analysis	Structured interviews
17	Smith <i>et al</i> .	2015	UK	Qualitative study	Semi-structured interviews
18	Tan <i>et al.</i>	2023	UK	Qualitative study	Semi-structured interviews
19	Tomlinson <i>et al.</i>	2020	UK	Qualitative study	Semi-structured interviews
20	Tu et al.	2021	China	Qualitative study	Focus groups followed by in- depth interviews

Data extraction*

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Stricts Results Description Description <thdescription< th=""> <thdes< td=""><td></td><td>carer burden and</td><td></td><td></td><td></td><td></td><td>•Decision -making.</td><td>lat 20</td><td>to time constraints.</td></thdes<></thdescription<>		carer burden and					•Decision -making.	lat 20	to time constraints.
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Image: Control of all in the status of the status		outcomes.							
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 Beller and beller an	Bernhard et al.	To investigate the	Qualitative study	People with type 2	People with type 2 Diabetes	Social resources (family/ Relatives	Preparation and organisation.	Receive direct assistance.	•As participants opted in to the focus groups, they may have a grea
integrise of particles Production-free data Production-free	(2017)	challenges and	Focus groups	diabetes(n=25)	(T2DM), using (oral	friends).	Administrations.	•Lack support.	interest in medication self-management and may represent the
 web ys2 2 cates: web ys2 cat	Germany	strategies of patients		Participated in 4 focus	hypoglycaemic agents and/or	 Professional friends (e.g., doctors). 	Medication-related information:	•Patients emphasised the	perspectives of more active patients.
 Interface Interface		with type 2 diabetes		groups - conducted with 6 to	insulin)	•Peers.	obtaining and sharing information.	company when experien a crowal	About half the patients were members of self-health groups (SHGs).
regrote of the netization regreter the concers transformed bein upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the them upport statustic. protice per dopoint the concers (72 use in concers) being of the the concers (72 use in the conc		mellitus (T2DM)		8 German or Turkish speaking	•Mean age of 64 ± 8.6, (49-	•Half were living in partnership	 Monitoring and tracking. 	moments such as hypoglycaer	we do not know the perspective of potential participants who chose not
 Interpretent of the management of t		regarding daily		participants per group.	77) years	(56%, n = 14).		effects.	participate. Incorporating their experiences may have generated a ful
 Indication reginals Indication reginals<		management of their			Patients have other Long-				picture of the situation.
here de la construit de la con		medication regimen			term conditions (LTC) such as			ng ng	
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Are if of all Constraints receives complex metalities Set # 16, 1.7. Set # 16, 1		support networks.			Mean number of other LTCs				
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1000000000000000000000000000000000000	Bieri et al.	To explore and analyse	Qualitative study	•Older adults'(OAs), health	Polymedicated older adults	•Spouse/partner(n=10).	Preparation and organisation.	• Informal carers were not always involed	The protocol involved the plan to systematically recruit one HP for each of the plan to systemato
Sinterinant Underly due 1 and Interviews Inter	(2021) Switzorland	polymedicated nome-	Semi-structured	care providers and informal	Managing at least 5 different	Daughter-in-law(n=1) Children aged 18 and above (n=6)	Administrations. Pominding	in medication management, and they aid	OA interviewed. However, this prov
individual tensions 0.07 range (5-21). 0.07 ran	Switzenanu	nersonal beliefs about	interviews	•Older adults'(OAs)	Mean number of medicines	• children aged 16 and above (II=0).	Medication-related information:	•Some OAs expressed their whees not to	For some HPs, mainly general practitioners, our research objective v
medication (n=28) mean age 81.1 (66-94) about their polyphamacy. Some age involved in their polyphamacy management. Working in the upare of the upare		and stances on their		individual 2 interviews	9.0 range [5–21].		obtaining information.	be particularly involved in the informed	not a priority, although each OA designated the main
prescriptions. We do years old. expressed their refusal to get on worked pademic compromised participant recruitment due to the value on uppaldation of interest. individual interviews (n-13) individual interviews (n-14) individual int		medication		(n=28) mean age 81.1 (66-94)			 Monitoring and tracking. 	about their polypharmacy.	involved in their polypharmacy management. Working in the context of
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Conor et al. (2021) USA 3 4 5 6 7 8	To characterise caregiver medication assistance for older adults with multiple chronic conditions.	Qualitative subset study Semi-structured interviews	Informal carers (n=24) •Eighteen carers were independent without assistance from paid carers. •Mean age of 61 years (SD 12.5); 68% were female (68%).	 People managing ≥3 chronic conditions and prescribed ≥5 medications. Mean age of 73 years (SD 6.4) and were managing an average of 5 chronic conditions and 7 daily medications. 	 Spouse/Partner. Child (18 years and over). Other family member or friend The majority were the patient's spouse (40%) or adult child (44%). 	 Preparation and organisation. Administration. Reminding Monitoring and tracking. 	Active involvement (n= 6). OPeripherally Involved (n=5). Not Involved (n=7). Not Involved (n=7).	 Findings are limited to a small sample of English-speaking caregivers of older adults in one urban city who were contending with MCC and multidrug regimens. However, we purposefully included caregivers to older adults with high medication burden, as these caregivers are more likely to assist with complex medication regimens. Furthermore, we enrolled caregivers actively engaged in a caregiving role, which may have prevented the observation of other potential typologies. Additionally, we only interviewed caregivers and did not obtain the perspectives of the older adults. The cross-sectional study design does not allow us to examine how caregivers assume new roles or how medication management responsibilities change over time.
9 10 Francis et al. 11 (2002) 12 UK 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28	To document the roles and responsibilities of informal carers in the management of medication for older care recipients, the extent to which specific activities are undertaken and to relate these to carers' coping and health.	Qualitative study Structured interviews & Quantitative analysis	• Informal carers (n=184) 61% of the carers were female, aged between 18 and 81 year (mean 55 years) and the male carers represent 39% aged between 30 and 91 years (mean 65 years).	Population aged over 65 years, belonging to ethnic minority groups and socio- economic status.	Caring for: •Mothers (n=50) •Father (n=12) •Mother in law (n=2) •Both mother and (n=35) •Husband (n=45) (m=47) •Grandmother (n=2) •Friend (n=9) •Neighbour (n=33) •Other relatives (n=6). •Partner (n=2). • • • • •	 Ordering. Collecting. Maintaining equipment. Maintaining supply. Buying medication or other remedies. Preparation and organisations. Administration. Reminding. Medication-related information: obtaining and sharing information. Decision-making. Monitoring and tracking. 	The extent of involvement contractions of the care recipient's. The extent of involvement contractions of the care recipient's. The extent of involvement contractions of the care recipient's. Solution of the care recipient's of the management of medice of the care recipient's of the management of medice of the care recipient's of the management of medice of the care recipient's of the management of medice of the care recipient's of the management of medice of the care recipient of the care recipient's of the management of medice of the care recipient's of the management of medice of the care recipient of the care recipient of the care recipient needed the medice of the care recipient needed the medic	•Only those carers whose assistance involved the collection of prescriptions were eligible for inclusion in this study. Some pharmacists provide prescription delivery services to clients, and, therefore, carers who use these services and provide medication-related assistance in the home would not have been identified female carers were more likely to agree to participate, the proportion of female carers (61%).
29 Garfield et al. 30 (2021) 1 (UK) 32 The study was corried 33 Out in two countries: the UK and relend. 34 This article presents 36 37 38 39 40 41 42 43	To explore home medicine practices and safety for people shielding and/or over the age of 70 during the COVID-19 pandemic and to create guidance, from the patient/carer perspective, for enabling safe medicine practices for this population.	Qualitative cross- sectional study Semi-structured interviews	 People with LTCs and corona virus (COVID-19) Informal carers Fifty people were interviewed (16 males, 34 females; mean age 68 years, range 26–93 years). Nine reported having a more dominant role in helping manage medicines for another adult with managing their own medicines and focussed on their carer role during the interviews. Seven of these were female. Ten were living alone 	People shielding during the COVID-19 pandemic and/or they were aged 70 years or more and were using at least one long-term medicine. In the study the number of medicines being taken found to be ranged from 1 to 17.	•Family, friends and/or community networks.	Ordering. Collecting. Buying over-counter medications. Maintain supply. Medication-related information: obtaining.	•Varied based on the relative family, friends and the commerce Bibliographique c chnologies.	 Those people we did not reach may have experienced more difficulties with their medicines during the pandemic. However, a survey carried out with people with disabilities reported those with a higher educational level experiencing more difficulties with obtaining medicines during the pandemic. The reason for this remains unclear. Despite our relatively large sample, new themes were constantly emerging during data collection and we cannot be sure that our sample size led to theoretical saturation. Despite efforts to increase the number of male participants, more females than males participated; this may be because they were more likely to assist with others' medicines. These initial results are only from one country and may not be generalisable elsewhere. The findings from Ireland, once available, will shed further light on generalisability.
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management of community-welling older adults diagnosed older adults diagnosed with dementia, their informal caregivers and porfessionals who assist them. In particular, we sought to understand the barriers and facilitators related to managing their • • Monitoring and tracking. • very important. However, they were go oncerned about safety issue and the medication use. • • every important. However, they were go oncerned about safety issue and the medication use. • • every important. However, they were go oncerned about safety issue and the set of the set	transferable to other settings or popu	as transferable to other settings or	e to other settings or populations.
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) medication and multiple methods family caregivers and paid •Son. •Collecting. •Collecting. caregiver. This criterion eliminated the participation of mark	caregiver. This criterion eliminated	ent caregiver. This criterion elimi	This criterion eliminated the participation of
Ja management issues Semi-structured providers. •Wife. •Maintaining adequate supply. activities.	individuals who were living at hom	individuals who were living at	who were living at home alone, and who r
taced by seniors with interviews and focus •Seniors receiving home care •Granddaughter •Preparation and organisation. •Engaging in shared accoundability (b) r medications.	medications.	pr medications.	S.
unume groups services(n=32) utners: •Administration. medication safety was multi-faceted and medication safety was multi-faceted and while the sample was somewhat diverse, it was limited to prevery household and their •Administration.	Although the sample was somewhat who could speak either English or Fre	Although the sample was some who could sneak either English	une sample was somewhat diverse, it was limite speak either English or French.
caregivers, and paid	•Qualitative researchers must be mi	Qualitative researchers must l	e researchers must be mindful of the possibilit
providers within •A total of 94 participants obtaining and sharing information.	providing responses they believe th	providing responses they belie	esponses they believe the interviewer is see
Canadian publicly were interviewed •Monitoring and tracking. •Monitoring and tracking.	reporting their actual experience.	reporting their actual experienc	neir actual experience.
funded home care individually.			
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Look et al. (2018) USA 3 4 5 6 7 8 9 10 11 12 13 14 15	To explore how informal caregivers manage medications for their older adult care recipients by identifying the activities involved in medication management and the tools or strategies used to facilitate these activities.	Qualitative study Focus groups	•Informal carers (n=29) mean age 67 (42 to 85) years.	Older adult aged 65 years or older. mean age 85 (65 to 106) years. individual with dementia (n=10 out of 29). •Approximately 80% of the caregivers managed 5 or more medications and 31% managed 10 or more.	Caring for: • Spouse (n = 14) • Parent or parent-in-law (n = 11) • Others (n=4) • Length of care: 2 -12 month.	Direct medication management activities (requiring physical handling): Ordering and picking up medications. •Splitting or cutting pills. •Organisation. •Administration. •Assistance, teaching and monitor to use several devices including: inhalers, nebulisers, nasal sprays, blood pressure machines, diabetic test strips, and anticoagulation monitoring. •Reminding. •Storage. Indirect medication management activities (requiring cognitive efforts): • Organise and keep track of medications. • Informational support. •Interact with the health care system.	Caregiver involvement in digt actives varied depending on the cap recipies's physical and cognitive hearth, we caregivers assisting relative thearth as few as the of the assistance with as few as the of the assistance with as few as the of the assistance with as few as the of the activities. Some indirect activities werding and interactions with various members of the health care system, which included doo nurses, pharmacles, health cao related to text a	 Sample size was small with only 29 caregivers in 4 focus groups within one rural county. Subjects were selected for convenience and focus groups were not continued until saturation was achieved. In addition, due to the use of a convenience sampling approach, an accurate response rate could not be determined. Differences between caregivers, including generational differences, living situation, and care recipient health status were not addressed. caution should be used in generalising the findings to a wider population of caregivers, as the participants may be more engaged or interested in medication management than non-participants. Compared to the national caregiving population, our sample had older caregivers and care recipients, more females, A higher prevalence of care recipient dementia, and managed a higher number of medications Care recipients with specific physical and mental health conditions may require specific medication management activities. The medication management needs associated with specific illnesses or conditions were not addressed in this study.
16 17 18 19 Maidment <i>et al.</i> 20 ⁽²⁰¹⁷⁾ 21 ^{UK} 22 23 24 25 26 27 28	To describe and understand the key challenges, in relation to medication issues, experienced by people with dementia and their informal carers dwelling in the community, and the potential role of community	An exploratory qualitative study design semi-structured interviews	 Informal carers, people with dementia and health care providers. Informal carers (n=11) People with dementia (n=4) Health care providers (n=16) (four GPs, five nurses, three social care professionals [paid formal carers] and four community pharmacists), were interviewed. 	People with dementia	Not specified	Ordering. Collecting. Tracking medication supply. Preparation and organisations. Administration. Medication-related information: obtaining. Decisions-making	Person with dementia very the process. Perso	 Findings are context-bound to the participants and study setting, like all qualitative research. Although we believe that the testimonies from the participants were particularly rich in content, as data were obtained from face-to- face interviews, we cannot avoid the possibility that participants may have given socially desirable responses. Only a limited number of participants from the Black and Minority Ethnic (BME) community were interviewed.
29 29 Mickelson et al. 30 (2018) 31 32 33 34 35 36 37 38 39 40	pharmacists. The purpose of this study was to investigate medication safety through the analysis of non-adherence events described by older patients with heart failure, a chronic illness associated with multiple medication use	Cross sectional data collected by qualitative study- interviews	 People with heart failure and informal carers. People living with heart failure (n=61). Mean age 73.31 (6.73, 65–86). Informal caregivers (n=30). 	 People with heart failure Patients regimens included a median of 16 medications (Mean=16.1, SD = 5.54) administered between one and six times per day. 	Family carers • Spouse (33) • Sibling (7) • Adult child/grandchild (2) 19 lived alone.	 Preparation and organisation. Administration. Monitoring and tracking. Medication-related information: sharing. Decision-making. 	Absent, delayed, or Anicomatte communication, information charing, and coordination of activities well factors of some events. Social support from informatic caregors was not always available, durge caregors 'work hours. Inadequate social support from caregors at Agence Biblic	 The data used for this analysis was gathered from a larger study of heart failure self-care, with only a subset of data collection methods designed to measure medication-related events. Performance-shaping factor were extracted from narratives, rather than from structured assessment instruments, and we did not use a specific error/incident taxonomy because none applied directly to this domain; however, our PSF categories and their definitions were based on prevailing systems models and incident taxonomies.
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Rai et al. (2018) Canada 4 5 5 7 8 9	To explore inflammatory arthritis (IA) patients' perspectives on tools and strategies to support chronic medication use using an interactive focus group activity.	Qualitative study Focus group	•Patients with inflammatory arthritis(n=27) Six focus group interactions with a total of 27 participants, including 17 women and 10 men. Age range (20-79) years.	Rheumatologist-confirmed diagnosis of IA, currently taking medication. Aged 19 and over. (eg, disease modifying anti- rheumatic drugs [DMARD])	Family carers •Spouse •Mother	Administration. Reminding.	en-2024-094443 on 25 Februa copyright, including for uses ∾	 Participant recruitment primarily took place in the metropolitan city of Vancouver; however, those living in rural communities were also invited to participate through phone or videoconference. Voluntarily participated in our study may be more likely to use their medications as prescribed and thus might not reflect the perspectives of "non-adherent" individuals.
10 11 12 13 14 15 ^{Read et al.} 16 ⁽²⁰¹⁸⁾	Few studies have examined the effect of demontia on	Qualitative study Semi-structured	Patients and informal carers when attending the glaucoma clinic with the patient	Main conditions glaucoma and dementia. Some outlenst found to house	Family carers Aged 50-90 years old; three quarters of those in the law coding role wave	Reminding. Administration.	Active accepters white approximate and able management of medication	•The study was limited to patients with mild dementia able to provide their own informed consent.
17 18 19 20 21 22	medication management strategies for glaucoma including how patient and carer needs impact adherence and long- term prognosis. We	Ground theory	Health care providers. Cohort A: Patients with glaucoma and dementia (n=23). Carers (n=22). Health care providers (n=9). •Cohort B Patients with glaucoma only	a Secondary condition type Aortic stenosis Chronic back pain Diabetes Diverticulitis	female. •Spouse •Adult children		Passive accepters: carers reconciliated at patients need their interaction to medication management, when the time to medication management, when the conditions are sometimes provided despite the patients due dynamics in the patient-carer relationship medications in the patient-care relationship medications in the patient descent	
23 24 25 26 27 28 29	report findings from a qualitative grounded theory study incorporating the views of patients, carers, and healthcare professionals.		(n=6). •Cohort C Patients with glaucoma and other non- dementia comorbidity (n=6). •From the total of 66 participants, 17 patients with dementia and glaucoma were			1en o	jopen.bmj.com/ or raining, and simila	
30 31 32 Ruark <i>et al.</i> 38 (2004)	Understanding how	Mixed-methods	interviewed twice in 6 months. Overall, this generated 83 semi structured interviews. •Twenty-five couples (50	•Main condition HIV	Spouses	•Collecting.	• Both partners expressed tip Q and Z	Men and particularly women living with diabetes were underrepresented
34 Malawi 35 36 37 38 39 40 41	couple relationships could be better leveraged to manage multiple diseases is an urgent task in ensuring the health of people living with cardiometabolic disorders and HIV.	observational study including: in-depth qualitative interviews.	individuals). •Females mean age 47.6 SD (5.8). •Male mean age 55.0 SD (7.0).	•Other condition including diabetes and hypertension.		Reminding. Medication-related information: sharing.	 illness was a mutual upponsitigy, conceiving of it as "our progen" refer than one partner's burden. Carer might try to be involved in her husband's medical care but met resistere. A carer wife spoke at length about the was ill. Additional non-spousal support was refer was refer to a support and the support of the support and the support was refer to a support was refer to a	in the sample, and we may not have reached saturation regarding the particular challenges of living with diabetes. •Participants may have represented their marriages and behaviours in socially desirable ways, although comparison of couples' accounts provided some indication of the veracity of their descriptions (when couples' accounts converged) or the presence of social desirability bias (when couples' accounts diverged).
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Smith et al. To report the number and type of problems UK experienced by informal carers when managing medication for older care recipients, and to relate these to measures of coping and health. 6 measures of coping and health. 9 10 11 12	Qualitative study Structured interviews & Quantitative analysis	Elderly with polypharmacy and informal carers. Elderly with polypharmacy(n=93). Mean age of care recipient 74(60–106) enformal carers (n=184) Mean age of ICs 65 (30–91). Female carers mean f 54.8 years compared with 64.6 years for male carers.	•Elderly with polypharmacy. •The median number of prescribed medications which care recipients were taking was five (range = 1-19). •Common medication indications: cardiovascular (n = 69 care recipients, 74%), central nervous system (n= 48, 52%) and gastro-intestinal (38, 41%) problems. they used different pharmaceutical formulations such as tablets, liquids, creams and inhalers	 Eighty-five carers (46%) were caring for spouse/partner, Looking after a parent/parent-in-law (n=79) (43%) Assisting a different relative, friend or neighbour (n=20) (11%). No other informal carer (n=103) (56%) Lived with the care recipient (n=120) (65%). 	 Ordering. Collecting. Maintaining adequate supply. Check prescriptions. Buying over-the counter medications. Preparation and organisation Administration. Administration. Reminding. Monitoring and tracking. Medication-related information: obtaining and sharing. Decision-making 	•Carers providing different leop of car- older people. •Carers providing different leop of car- older people. •Carers providing for uses related	 The recruitment rate of 25% is low, and therefore, caution must be exercised in generalising the findings to a wider population of carers of older people in a primary care setting, the sampling procedures were designed to reflect diversity in patterns of medication-related problems experienced by this group.
13 Smith <i>et al.</i> To examine the scope 14 (2015) and range of 15 medicines-related assistance provided by 16 family carers of people 17 with dementia, the 18 and to identify 19 how service provision 20 could become more 21 responsive to these 22 assistance 23 and to identify	Qualitative study Semi-structured interviews	 Informal carers Fourteen interviews conducted with carers aged from 45 to 86 years including eleven female and 4 males. People with LTCs Five interviews conducted with people aged from 81 to 93 years all of them were female. 	Dementia <u>living at home</u> including cardiovascular disease, respiratory problems, osteoporosis, joint pain and mental health problems. •People were found to take medication ranged from1 to 15 (mean 7).	Family carers •Daughters(n=10). • Sons(n=2). •Husband(n=1). •Wife(n=1). •Five carers lived with the care- recipient.	Ordering. Collecting. Maintain adequate supplies. Preparation and organisation. Administration. Administration. Reminding. Monitoring and tracking. Medication-related information: obtaining and sharing. Decision-making.	•Dependency on carer were were the Superior tests Superior tests Superior tests Superior tests and data mining, Al training, a	This study was limited in that it involved just a small number of carers from one part of London. Although the needs and perspectives of family carers in assisting with medicines may be replicated elsewhere, differences, e.g. in service provision, may affect carers' experiences.
20 Tan et al. To explore the experiences of treatment burden and 29 28 UK treatment burden and 29 29 capacity among patients with Parkinson's disease and their caregivers 32 31 and their caregivers 32 33 factors. 34 factors. 35 factors. 36 factors. 37 factors. 38 factors. 39 40 41 42	Qualitative study Semi-structured interviews.	 People with Parkinson's and informal carers. People with Parkinson's (n=9) aged 59–84 years. informal carers (n=8). 	People with Parkinson's disease (PwP) including dementia. • <u>All lived their home.</u> • <u>Three living alone.</u>	Family carers •Wife(n=10) • Husband (n=2) •Sister(n=1). • Daughter(n=2). Others: • Friends. • Neighbours • Church members • Parkinson's UK support groups. • Peers. No carer (n=2)	 Ordering. Collecting. Getting prescriptions right. Preparation and organisation. Reminding. Monitoring and tracking. Medication-related information: obtaining. Decision-making. 	People with Parkinson's rend on mein caregivers or friends to complete this say as they were unable to used complete themselves due to tremorial had more memory, and experienced mobility issues. Complete the say of the sa	 The small number of participants representing each characteristic mean that not all experiences of treatment burden may have been captured. However, there were several limitations. Firstly, this study was conducted in the UK with a publicly funded national health system and the findings may not apply to PwP and caregivers in other countries with different health systems, although they are likely to experience similar challenges worldwide. Secondly, there was a lack of ethnic diversity among participants which may limit the transferability of the findings, although this aligns with the local population of the study region. Thirdly, data regarding financial capacity or deprivation levels were not collected and these factors may influence the experiences of participants. Although reasons for not participating were not recorded, eligible participants with PD who did not respond to the study invitation were aged 67–87 years old, diagnosed with PD between 1–23 years, living alone or cohabiting, with or without a caregiver, and two PwP who had early cognitive impairment. Whilst these were similar characteristics to participants recruited in this study, participants with high treatment burden or less capacity may not have consented to participate in the interviews due to the limited time constraints in their everyday lives trying to manage their PD. Therefore, there may be other aspects of treatment burden and capacity not reported in the findings.

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Тотіілson <i>et al.</i> (2020) UK 3 4 5 6 6 7 8 9 10 11	To explore the experiences of older patients and their family carers as they enacted post- discharge medicines management, focusing on identifying what helps and hinders them.	Descriptive qualitative study Semi-structured interviews.	Older adults and informal carers. Older participants(n=27). Female(n=21); mean age 84 years). Informal carers (n=9).	People aged 75 years or over; used five or more medicines; lived with LTCs (frailty and type 2 diabetes mellitus were used as exemplar conditions in this study); and had medicines change during their admission to hospital. Findings shows that All participants had at least one medication change or recommendation made about their medicines (mean 4.6 changes).	 Spouse. Daughter. Living arrangement: lived with Spouses (n=9) Others(n=1) Living alone(n=19) Carers: No one (n= 6) (22%) Family (n=17) (63%) Combination of family and social services 1 (4%). 	 Helped with rationalise and monitor the stock of medicines and supply. Preparation and organisation. Reminding. Medication-related information: obtaining. 	•Few participants simply could ot makes their medicines and relied of these with as formal carers, to administer them of the was often due to their delines of deteriorating memory or reduced capaeous after discharge. One patient has 2 family cares. The level to which they maked on 25 February 200 The set of the s	•The sample was limited in its ethnic diversity and does not represent the wider population of the UK. It is therefore unclear whether the findings are transferrable to other patient groups and to the population as a whole.
12 13 14 Tu et al. 15 China 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 20	To explore: i) how is the cause and management responsibility for diabetes appraised by older Chinese couples? ii) What are their main barriers in daily care activities? and iii) Is there any gender-specific pattern associated with diabetes management?	Qualitative study Focus groups followed by in-depth interviews	Four focus groups with 11 couples and 10 in-depth interviews with 10 couples Mean age of the couple were 67 years old.	Older couples aged 60+, where at least one partner had type 2 diabetes mellitus (TZDM).	Spouse	Reminding Monitoring and tracking.	 Except for one couple, where the participation of the remained relatively independint remained relatively independent to the partner of the par	 Sample was relatively small and was recruited through purposive sampling. The couples interviewed were likely to represent the youngerold, with a satisfying marital relationship. Our findings may underestimate the T2DM management challenges faced by the oldest-old and be biased towards positive spousal interactions and cooperative coping styles. Nonetheless, our findings about the interviewees' insufficient knowledge and management barriers may also hold true among older patients without spousal support and warrant further investigations to identify their dilemma regarding diabetes care considering their specific family context. Furthermore, we interviewed the couple dyad together to gain insights into their interactional processes. Although both spouses were encouraged to participate equally, the discussion was sometimes dominated by one spouse, and the other party may qualify their responses due to their partner's presence.
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Search strategies

Medline search strategy

Ovid MEDLINE(R) and In-Process, In-Data	Review & Other Non-Indexed Citations <1946 to February 02, 2024>
Facets	Key terms
Long term condition(s)(LTC)	1 chronic disease/ or noncommunicable
	diseases/
	2 "chronic illness*".ab,ti.
	3 "chronic disease*".ab,ti.
	4 "chronic condition*".ab,ti.
	5 NCD*.ab,ti.
	6 "noncommunicable disease*".ab,ti.
	7 "non-communicable disease*".ab,ti.
	8 "noncommunicable illness*".ab,ti.
	9 "non-communicable illness*".ab,ti.
	10 "long-term disease*".ab,ti.
	11 "long-term illness*".ab,ti.
	12 "long-term condition*".ab,ti.
	13 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or
	10 or 11 or 12
Medication management (MM)	14 medication therapy management/
	15 Medication management.ab,ti.
	16 Medicines management.ab,ti.
	17 Medicines*.ab,ti.
	18 Medication*.ab,ti.
	19 14 or 15 or 16 or 17 or 18
Informal carers (ICs)	20 Caregivers/
	21 Informal carer*.ab,ti.
	22 Caregiver*.ab,ti.
	23 Carer*.ab,ti.
	24 Care giver*ab,ti.
	25 Family.ab,ti.
	26 Family caregiver*.ab,ti.
	27 Relatives.ab,ti.
	28 friend*.ab,ti.
	29 exp parents/
	30 parent*.ab,ti.
	31 grandparent*.ab,ti.
	32 spouse*.ab,ti.
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Key terms

chronic disease/ or non communicable

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"noncommunicable illness*".ab,ti.

"non-communicable illness*".ab,ti.

medication therapy management/

Medication management.ab,ti.

Medicines management.ab,ti.

14 or 15 or 16 or 17 or 18

Medicines*.ab,ti.

Medication*.ab.ti.

Informal carer*.ab,ti.

Caregiver*.ab,ti.

Care giver*.ab,ti.

Family caregiver*.ab,ti.

Carer*.ab,ti.

Family.ab,ti.

exp parent/

parent*.ab,ti.

exp spouse/

spouse*.ab,ti.

friend*.ab,ti.

Relatives.ab,ti.

13 and 19 and 35

27 or 28 or 29 or 30 or 31 or 32 or 33 or 34

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exp grandparent/

grandparent*.ab,ti.

caregiver/

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"chronic disease*".ab,ti.

NCD*.ab,ti.

"chronic condition*".ab,ti.

"long-term disease*".ab,ti.

"long-term illness*".ab,ti.

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PsycINFO search strategy

APA PsycINFO <1806 to January Week 5 2024>			
Facets	Key terms		
Long term condtion(s) (LTC)	1 Chronic Illness/		
	2 "chronic illness*".ab,ti.		
	3 "chronic disease*".ab,ti.		
	4 "chronic condition*".ab,ti.		
	5 NCD*.ab,ti.		
	6 "noncommunicable disease*".ab,ti.		
	7 "non-communicable disease*".ab,ti.		
	8 "noncommunicable illness*".ab,ti.		
	9 "non-communicable illness*".ab,ti.		
	10 "long-term disease*".ab,ti.		
	11 "long-term illness*".ab,ti.		
	12 "long-term condition*".ab,ti.		
	13 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or		
	10 or 11 or 12		
Medication management (MM)	14 Medication management.ab,ti.		
	15 Medicines management.ab,ti.		
	16 Medicines*.ab,ti.		
	17 Medication*.ab,ti.		
	18 14 or 15 or 16 or 17		
Informal carers (ICs)	19 Informal carer*.ab,ti.		
	20 Caregiver*.ab,ti.		
	21 Carer*.ab,ti.		
	22 Care giver*.ab,ti.		
	23 Family.ab,ti.		
	24 Family caregiver*.ab,ti.		
	25 Relatives.ab,ti.		
	26 friend*.ab,ti.		
	27 parent*.ab,ti.		
	28 spouse*.ab,ti.		
	29 grandparent*.ab,ti.		
	30 caregivers/		
	31 exp parents/		
	32 exp spouses/		
	33 19 or 20 or 21 or 22 or 23 or 24 or 25 or		
	26 or 27 or 28 or 29 or 30 or 31 or 32		
501	34 13 and 18 and 33		

CINAHL search strategy

CINAHL		
Facets	Key terms	
Long term condtion(s) (LTC)	S1. (MH "Chronic Disease") OR (MH "Noncommunicable Diseases")	
	S2. TI ("chronic illness*" or "chronic disease*" or "chronic condition*" or "NCD*" or "noncommunicable disease*" or "non communicable disease*" or "non-communicable disease*" or "noncommunicable illness*" or "non-communicable illness*" or "non communicable illness*" or "long-term disease*" or "long- term illness*" or "long-term condition*") OR AB ("chronic illness*" or "chronic disease*" or "chronic condition*" or "NCD*" or "noncommunicable disease*" or "non communicable disease*" or "non-communicable disease*" or "noncommunicable illness*" or "non-communicable illness*" or "noncommunicable illness*" or "long-term disease*" or "long- term illness*" or "long-term condition*")	
	S3. S1 or S2	
Medication management (MM)	S4. (MH "Medication Management") S5. TI (medication therapy management or medication management or medicines management or "Medicines*" or " Medication*") OR AB (medication therapy management or medication management or medicines management or "Medicines*" or "Medication*")	
	S6. S4 or S5	
Informal carers (ICs)	S7. (MH "Caregivers") OR (MH "Parents")	
	S8. TI ("Informal carer*" or "Caregiver*" or "Carer*" or "Care giver*" or "Family" or "Family caregiver*" or "Spouse*" or "Parent*" or "Friend*" or "Grandparent*") OR AB ("Informal carer*" or "Caregiver*" or "Carer*" or "Care giver*" or "Family" or "Family caregiver*" or "Spouse*" or "Parent*" or "Friend*" or "Grandparent*")	
	S9. S7 OR S8	
1,003	S10. S3 and S6 and S9	

Web of Science search strategy

Web of Science		
Facets	Key terms	
Long term condtion(s) LTC	 TS=("chronic illness*" OR "chronic disease*" OR "chronic condition*" OR "NCD*" OR "noncommunicable disease*" OR "non communicable disease*" OR "non-communicable disease*" OR "noncommunicable illness*" OR "non-communicable illness*" OR "non communicable illness*" OR "non communicable illness*" OR "long-term disease*" OR "long-term illness*" OR "long-term condition*") 	
Medication management (MM)	 TS=("medication therapy management" OR "medication management" OR "medicines management" OR "Medicines*" OR " Medication*") 	
Informal carers	 TS=("Informal carer*" OR "Caregiver*" OR "Carer*" OR "Care giver*" OR "Family" OR "Family caregiver*" OR "Spouse*" OR "Parent*" OR "Friend*" OR "Grandparent*") 	
1924	4. 1 and 2 and 3	
search strategy	Z	

Scopus search strategy

	Scopus
۲)	FITLE-ABS-KEY ("chronic illness*" OR "chronic disease*" OR "chronic
со	ondition*" OR "NCD*" OR "noncommunicable disease*" OR "non communicable
di	sease*" OR "non-communicable disease*" OR "noncommunicable illness*" OR "non-
со	mmunicable illness*" OR "non communicable illness*" OR "long-term disease*" OR "long-
te	rm illness*" OR "long-term condition*") AND TITLE-ABS-KEY ("medication therapy
m	anagement" OR "medication management" OR "medicines
m	anagement" OR "Medicines*" OR " Medication*") AND TITLE-ABS-KEY ("Informal
ca	rer*" OR "Caregiver*" OR "Carer*" OR "Care giver*" OR "Family" OR "Family
ca	regiver*" OR "Spouse*" OR "Parent*" OR "Friend*" OR "Grandparent*"))

The role of informal carers in medication management for people with long-term conditions; A systematic review

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The role of informal carers in medication management for people with longterm conditions; A systematic review

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Abstract

Objectives: To explore the literature about the role of unpaid informal carers in medication management for people with long-term conditions.

Design: Systematic review designed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Information source: MEDLINE (Ovid), Embase (Ovid), PsycINFO, CINAHL (EBSCO), Scopus, and Web of Science were searched from inception until April 2024. Additional papers were identified by searching backwards and forwards the reference lists of included papers.

Eligibility criteria: Primary research studies were included if they reported medication-related activities undertaken by carers for people with long-term conditions. Qualitative and mixed methods studies were considered without restriction on language or country.

Data extraction and synthesis: Relevant data were extracted and summarised in a table. The Mixed Method Appraisal Tool was used for quality assessment. Data were narratively synthesised.

Results: From 12473 identified records, 107 underwent full text screening and 20 studies were included. Family carers were the predominant type of carer. Spouses and adult children constituted the largest caregiving dyads. Based on the required skills two groups of roles were identified; physical roles, such as prescription management, and cognitive roles such as decision-making. Carers used different strategies and tools to undertake medication-related activities including compliance aids and alarms. However, carers reported challenges in their experiences of caregiving, flagging up their need for additional support and education to commence such activities.

Conclusion: Informal carers undertake a wide variety of medication-related activities. The studies emphasised the need to support families as partners in health outcomes. This systematic review identifies the importance of bridging the gap between carers and health care providers. More efforts are needed to empower carers towards better and safer caregiving. Future work could address how to optimise carer involvement and engagement and provide best practice recommendations for carers support.

PROSPERO registration number CRD42024506694.

Strengths and limitations of this study

- To our knowledge, this is the first systematic review investigating the role of informal carers in medication management for people with long-term conditions.
- Inclusion criteria were applied with no restrictions on language or country. •
- It was not possible to perform a meta-synthesis due to the heterogeneity in several ble . aspects.
- The outcomes for carers and care-recipients were described broadly.

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Introduction

The increase in long-term conditions (LTCs) among the population poses challenges to the health and social care system causing increasing morbidity, mortality and economic burden [1,2]. According to The Department of Health, LTC is used to describe "the *condition that cannot, at present, be cured but is controlled by medication and/or other treatment/therapies*"[3]. Alongside the rise in LTCs, there is increasing concern about the concurrent intake of multiple medications per person, referred to as polypharmacy [4–6]. Although five or more medications are commonly used to describe polypharmacy, there is no consensus on a specified number for polypharmacy definition [5,7]. Previous research has highlighted the likelihood of medication management complexity for people with LTCs [8]. Up to 50% of people with LTCs do not take their medications as prescribed leading to adherence problems [9]. In addition, there is a higher probability of medication related problems including drug-drug interactions, side effects, and medication misuse [4–6]. People with LTCs often require co-management and support with medication use, which can be offered by informal carers [10,11].

An informal carer is an umbrella term used to describe "anyone who looks after a family member, partner or friend who needs help because of their illness, frailty, disability, a mental health problem or an addiction and cannot cope without their support. The care they give is unpaid" [12,p.9]. According to the International Alliance of Carer Organizations (IACO), there are more than 63 million carers globally [13]. In the United Kingdom (UK), there are 5.8 million people acting as carer including 3.5 million female carers [14]. In spite of this, the figure might be higher due to the nature of informal caregiving, which are often not reported [14]. In 2021, the UK carers' input was estimated to be worth £162 billion annually, which is equivalent to the National Health Service (NHS) annual expenses in England and Wales [15].

People with LTCs frequently receive support from carers alongside health care providers as part of a "*care triads*" [16–19]. People with LTCs and their carers are more likely to require pharmacy services accessibility and continuous dealing with medications [20]. Pharmaceutical care services help carers to alleviate the burdens associated with their medication management roles [21]. The caregiving role can vary from basic daily assistance with bathing, eating or dressing to more complex medical tasks such as administering injections [22]. According to a scoping review, there is a large number of studies conducted on the informal caregiving experience of older adults with a single chronic condition [23]. The literature has typically focused on specific or broad disease states such as cancer, dementia and palliative care which in many cases are life-limiting [24,25]. However, there is a paucity of studies investigating this topic within other LTCs [23].

Less attention has been paid to the carers of people with LTCs; the carer role has been underestimated and carer's need for support is not well understood [26]. There is, however, no systematic review that explores the role of carers amongst people with LTCs. Therefore, this

review was conducted to answer the following question: what are the experiences of informal carers in managing medications for people with LTCs?

Methods

Design

This systematic review is reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA) guidelines (see **Supplemental material 1**) [27]. The research question is narrowly focused on the context of medication management. Thus, the systematic review approach was selected over the scoping review for the following reasons: confirm current practices, address variations, identify new practices, and highlight areas for future research[28].

Search strategy

The following databases were searched from inception until April 2024: MEDLINE (Ovid), Embase (Ovid), PsycINFO, CINAHL (EBSCO), Scopus, and Web of Science. The terms used in the search strategy were related to medication management, informal carers, and long-term conditions (see **Supplemental material 2**). The search strategy was modified to each database to suit its indexing structure, syntaxes, and subject headings. Reference lists of all included papers were screened backwards and forwards to identify additional papers.

Study selection

Inclusion criteria for studies were determined in line with SPIDER (Sample, Phenomenon of Interest, Design, Evaluation, Research type) tool (see **Table 1**). Initial screening of titles and abstracts was completed by the primary researcher (MA) and checked by (CR and LL). Full-text studies were screened and reviewed independently by at least two members of the research team (MA, CR and LL) using the same criteria. Disagreements were solved through discussion. Studies that did not fulfil the inclusion criteria were excluded.

Table 1: SPIDER criteria

ē	Inclusion	Exclusion
Criter		
	• Adult living in the community with one or	Papers focused on:
	more long-term conditions.	People below 18 years.
		 People in settings where they receive additional assistance with their medication (in-patients or nursing homes, home carers, Macmillan, or hospice at home care.
		• People at the immediate end of life.
S		• People with acute illness or injury.
P&I	 Medication management activities provided by an adult informal carer or equivalent. 	 Papers focused on: Paid carers only. Young carers below 18 years old. Unspecified age of young carers.
	 Primary peer reviewed papers. From inception until April 2024. Any language. Any country. 	 Systematic reviews, literature reviews and realistic reviews. Conference abstract, editorial, book chapter, report papers, leaflets, meeting notes and dissertations.
D		Not available as full-text papers.
Ш	 Carers activities in medication management including: (i) care-recipients, carers and health care providers experience of carer role; (ii) care-recipient and/or carer outcomes such as barriers, burdens and facilitators; (iii) and the nature of carer-recipient dyads. 	N/A
Ж	 Qualitative and mixed methods studies including a qualitative elements of medication management. 	No qualitative data.

Data extraction and evaluation

Data were extracted and summarised by (MA) using a standardised data extraction form (see **Supplemental material 3**). The Mixed Methods Appraisal Tool (MMAT) was used to appraise qualitative and mixed methods studies [29]. The overall assessment was scored as follows: low

quality (0-1), medium quality (2-3), and high quality (4-5). Quality assessment was completed by two authors independently. While the primary focus was on qualitative data, mixed methods papers were included, and these were compressively assessed for their methodological approaches using the relevant section(s) of the MMAT. Disagreements were solved through discussion (see **Supplemental material 4**).

Data synthesis

Narrative synthesis was used to present findings in three steps [30]. Firstly, developing a preliminary synthesis of the findings of the included studies. This step was conducted by constructing a descriptive summary of the included studies by tabulating studies' details and identifying types of provided activities. Secondly, exploring relationships within and between studies by categorising and structuring into themes based on the carer activities. Thirdly, to draw a generalisable conclusion based on this synthesis. No planned meta-synthesis considering the expected heterogeneity of the included studies in terms of care-recipient conditions, carer demographics, carer dyads, and medication management activities. Therefore, in such complex heterogeneity, narrative synthesis is the primary choice [30].

Results

Data extraction and evaluation

The search identified total *12,473* articles; an additional 13 articles were identified through manual searching. After removing duplicate records, *5947* studies were screened. One hundred and seven articles were eligible for full-text screening. A total of 20 studies were included in the review (see **Figure 1**).

Of the 20 included studies, two used mixed methods [31,32] and four were sub-studies, conducted as a part of larger studies [33–36]. Three studies were published before 2010 [31,32,37], seven were published between 2020–2024 [33,36,38–42], with most published between 2010-2019 [34,35,43–50].

According to the World Bank classification of countries by the World health organisation [51]. Most of the studies were conducted in high-income areas [31–35,37,38,40–50]. The UK [31,32,37,38,40,42,44,47,49,50], Canada [43,45,48], the United States [33,35,46], Germany [34], and Switzerland [41]. Another study was conducted in China, a country classified as upper-middle-income [39] and one in Malawi, a low-income country [36].

According to MMAT tool, all studies apart from two ranked as a high quality based on the qualitative criteria of assessment [31–33,36–50]. The two studies rates as medium were substudies and there was a lack of clarity regarding how the data were collected relative to the original study [34,35]. No studies were excluded based on the quality assessment.

Carers demographics and challenges

Carers helped both family and non-family members. Carer-recipient dyads were predominantly familial [31–50]. Primarily including spouses [31–33,35–39,41–44,46,48–50], adult children [31–33,35,37,38,41–44,46,49,50], relatives [31,32,34], siblings [35,37,42], adult grandchildren [32,35,43], and parents [48]. Support was also provided by friends [31–34,40,42,43,45] and neighbours [31,32,42,43,45].

In term of care-recipients, nine studies were conducted on older adults with polypharmacy as reported by the authors [31–33,37,38,40,41,43,46]. Eleven studies focused on investigating specific conditions including chronic obstructive pulmonary disease [44], dementia [45,47,49,50], glaucoma [49], heart failure [35], human immunodeficiency virus [36], inflammatory arthritis [48], Parkinson disease [42], and type II diabetes [34,39].

Carers prioritised care-recipients health over their own needs [37,39,43–45,47]. Some studies reported that carers and care-recipients held contrasting beliefs about medication effectiveness and need which complicated medication use and management [31,37,41,44,50]. Where carers had poor skills in handling medications this resulted in safety concerns [37,39,43,45].

Carers frequently experienced difficulty in accessing health care providers and services [37,38,40,42,47,50]. They were critical about the limited consultation timeframe which made it challenging to ask questions [43,47,48,50]. There were some concerns about the exclusion of care-recipients from the conversation during consultations when the carer attended [50]. Sometimes, carers were not informed about prescription changes, either due to absence or exclusion from consultations [50]. Challenges were more likely to occur when new medications were added [38,41,45,50]. It was reported that poor relationships with health care providers resulted in difficult medication management [31,35,38].

Medication management roles

A wide range of medication management roles and related activities were offered by carers across the included studies (see **Figure 2**). Depending on the skills required, the roles carers were involved in could be considered either cognitive or physical [46].

Carers involvement in medication management was varied and highlighted as an obligation [37,41,43,47]. Carers pointed out that their role in medication management had evolved from 'obligation' to 'automatism' and 'habit' [41]. The involvement of carers was varied, ranging from participation in some activities to taking full responsibility for medication management [31,32,37–40,43–46,50]. Care-recipients often requested carers assistance regardless of their physical and cognitive capabilities [37,41,49]. Respecting care-recipients autonomy and independence was valued by carers, leading to partial or no involvement of carers [33].

Physical roles

Prescription management

In 12 studies, prescription management was reported [31,32,36–38,40,42–44,46,47,50]. This role involved several activities, including ordering [31,32,37,40,42–44,46,47,50], collecting [31,32,36,37,40,42–44,46,47,50], buying over-the-counter medications [31,32,40], maintaining adequate stock [31,32,38,40,43,44,47,50], and purchasing equipment for prescribed medications[32,44] such as nebulisers parts [44].

Carers reported difficulties navigating ordering systems or procedures [31,32,37,50]. Also, carers hassled with managing medication supplies [31,38,40,44,47]. Keeping track of supplies was challenging in certain circumstances such as running out of stock during the weekend [47], post-discharge [38] or the COVID-19 pandemic [40], and obtaining medications from multiple locations [40].

Preparation, organisation and administration

Carers contributed to medication preparation and organisation in 15 studies [31–35,37,38,41–47,50]. Carers used pill-boxes to arrange medications[32,33,35,41,43,45–47,50]. Pill-boxes were filled away from the care-recipient for higher accuracy [35]. Carers complained about the slot size and space [46]. Conversely, some carers acknowledged the usefulness of pill boxes in tracking and receiving the correct medication [47,50]. However, more concern were raised about errors and mistakes [50].

Carers used other types of containers to organise medications such as coloured box lids [41], coloured coded jars [32], plates [32,43,46], glasses [32,46], pots [37,38], and ordered bottles per dose[33]. When necessary, carers prepared doses in advance by setting inhalers [43], opening containers [31,32,42,43], dissolving [42,45], diluting [44], splitting [32,46], and crushing [45] doses. Beyond preparing doses, carers took responsibility for cleaning and maintaining nebulisers [44].

Carers participated in medication administration across 15 studies [31–35,37,41,43–50]. Carerecipients received assistance with several pharmaceutical formulations or devices [31–35,37,41,43–50] (see **Supplemental material 5**). Carers reported challenges with the lengthy process of nebuliser-related activities and possible technical problems [44]. Dealing with different inhaler devices caused problematic experiences [44]. It was challenging for carers to provide frequent support throughout the day [31]. Also, it was confusing to prepare and provide multiple medications with similar characteristics, such as being a white colour [35,46]. Carers used strategies to address these issues by writing indications or strengths on the bottles [46]. Frequent dosing was flagged in other included studies as a broader challenge in medication management [32,35,42,44,45,47].

The practice of storing medications by carers was reported in three studies [37,43,46]. Storing medications in multiple places impacted care-recipient safety and adherence [43]. For example, in one study care-recipients experienced difficulties finding medications that were lost between cupboards [43]. Carers stored the medications away from care-recipients to minimise the risk of medication errors, especially for people with dementia [37,46]. Large quantities of medication were kept in a lockbox [43,46].

Cognitive roles

Reminding

Fourteen studies reported the role of carers in reminding care-recipients to take their medication regularly [31–33,36–39,41,42,45,46,48–50]. Different strategies were used to facilitate this role (see **Supplemental material 6**). Carers expressed concern about the care-recipient's dependency on carers to provide frequent dose reminders [49]. Reminding strategies were used either to remind carers themselves or care recipients [46]. Routine markers including placing notes or medication in visible places or linking doses to daily routines were frequently used [31–33,37,41,46,49]. However, routine markers were not effective for some care-recipients, especially for those with memory issues or where notes were disregarded by care-recipients [46,49].

Monitoring and tracking of medications

Tracking and monitoring health conditions and/or medications was cited across 15 studies [31– 35,37,39,41–46,49,50]. This entailed side effects monitoring [31,32,37,41,44,46,50], tracking medication intake [33,35,42,45,46,49,50], and checking prescriptions is correct [31,42]. Carers created or used printed a medication list to track medication-related information and activities or guide care-recipients [34,35,43,46]. Carers raised some concerns about side effects and medication tolerance [37,41,44,50]. As a result of monitoring and tracking, carers were able to detect potential side effects before health care providers did [46]. The results in two studies showed that carers also undertook disease parameters monitoring such as monitoring biochemical readings and markers e.g. coagulation and glucose, and other health monitoring [39,46].

Carers needing medication-related information for decision-making

Carers were involved in obtaining and/or sharing medication-related information in 15 studies [31,32,34–38,40–44,46,47,50]. Carers searched for information relating to medications or disease management from varied sources including general practices [44,50], other health care providers [31,32,37,38,40–42,46,47,50], the internet [38,42,43,46,50], libraries [42,46], medicine leaflets [31,32,38,41,44,50], prescription printouts [46], magazines [50], local support groups [42], charities [42], and manufacturing manuals [44]. Other family members with medication

experience were consulted for information [34,42–44]. As in other carers, peers acted as a source to exchange information and experiences [34].

For carers, it was important to get the right information and to understand the instructions [47]. Carers struggled to understand the patient information leaflet in two studies [31,50], but were keen to read prescription instructions and medication names carefully in order to avoid potential errors [42]. Furthermore it was reported that health care providers gave incomplete or unclear instructions [44]. The risk of poor medication labelling, inadequate documentation, and not having user-friendly documents was a source of carers frustration [31,43]. Several carers reported lacking knowledge and understanding of medication-related information [31,35,37–44,47,50]. Carers emphasised their need for more information about the indication [31,50], frequency [44,50], and side effects [31,37,44,50] of medications. Particularly information about new medications was a critical need for carers [38,41,45,50].

In eight studies, carers debated the risks and benefits of the care-recipient's medications [31,32,35,42,44,46,47,50]. Suggestions by carers to change medications were varied and included initiating [32,44], adjusting [31,32,35,42,44,46,47], and stopping medication [31,35,44,50]. Changes in dose timing were made by carers in response to their own commitments and care-recipients needs [31,32].

Carers required medication-related information to monitor care-recipients and coordinate care with health care providers [46], and influence care-recipient adherence [32]. In particular, carers shared information with care-recipients [31,32,34,36,43,50] and health care providers [35,37,46]. A lack of medication-related information was associated with difficulty in decision-making [37,44,50]. Health care providers had commented on the importance of carers and care-recipients education to promote adherence [45]. Similarly, care-recipients suggested educating family members about their medications [48].

Discussion

This review highlights the diversity of carer roles and activities related to medication management and highlights the need to recognise carers are having expertise in the patient's lived experience. Carers support people with LTCs with cognitive and/or physical elements of medication management. Physical roles include (i) prescription management, (ii) preparation, organisation and administration, (iii) storage and cognitive roles include (i) reminding, (ii) monitoring and tracking of medications, (iii) medication-related information and decision-making. In the studies, carers took an integral and multi-faceted role ranging from basic physical assistance to independent decision-making and it is likely that the identified activities were interlinked. For example, monitoring for disease symptoms corresponds to administrating medications and further actions. Carers involvement was varied owing to changes in the care-recipients medications, conditions and needs.

Familial caregiving was the predominant type of carer-recipient dyad across the included studies. The findings of this review support the work of Manias *et al.* (2019), who reported the role of family carers in managing medication complexity and participating in decision-making [52]. This work, however, only focused on elderly people across transitions of care [52]. In our review, there was a range of dyads included but there was no noticeable difference between the dyads in the nature of the medication management activities carers were involved in.

Caring for people with LTCs was often associated with complexity. This experience can be explained by the lack of supportive resources while dealing with (i) multiple medications, (ii) different needs, and (iii) frequent activities. Given that carers involvement appears to be key in the medication management process, our findings suggest the need to better support carers for people with LTCs. According to the reviewed evidence, a systematic approach to support carers was lacking. Fragmentation was captured between carers and health care providers in terms of communication, education, and training. Although carers are involved in several medicationrelated activities, they do not receive structured training or education in this area. Carers have created their own strategies for medication management and modifying the available tools. This also aligns with previous findings, which showed that carers tend to discover undertaking their responsibilities by trial and error [53]. Of a particular concern, is that most carers are not able to establish communication and partnerships with health care providers to fulfil their needs. A similar position was offered by Gillespie et al. (2014), who emphasised that lack of information, training, and poor relationship with health care providers were the most common factors that negatively affect carers experiences [54]. Similarly, Pu et al. (2023), reported the failure of carers to be actively involved in pain management for people living with dementia due to the same factors [55]. Lawson et al. (2022), highlighted the need to support carers with information and training to mitigate caregiving burdens [56]. In the context of care transition and discharge planning, similar needs were flagged by carers [52,57].

Most of the studies included in this review indicate that carers were not actively involved with health care providers. More actions are needed to empower carers in medication management role. This should entail involving carers in consultations and decision making alongside care-recipients and health care providers. Along the same lines, Eriksen *et al.*(2020) recommended that health care providers need to escalate efforts in communicating and involving social networks in medication-related experiences for people with polypharmacy [58]. Pharmacies are one place recognised to have potential for better supporting carers [59]. Furthermore, familiarising carers with prescription management activities and processes. Medication management tools and strategies were anticipated to facilitate carer roles. However, different perspectives and attitudes were noted regarding using compliance aid and reminder strategies across the included studies. Therefore, better evidenced tools and strategies could be designed with carers in mind as the end users.

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To our knowledge, this is the first systematic review that aimed to explore the role of carers in medication management for people with LTCs. The inclusion criteria do not impose any restrictions on language or country, ensuring that all relevant literature on medication management and carers is captured. Studies that were not specifically designed to explore carers medication-related activities but did report some relevant data were included and as such it was not possible to perform a meta-synthesis. The reason for this is threefold: (i) the heterogeneity of included studies, (ii) the range and variety of medication-related activities and (iii) the variation in care-recipients' conditions. In this review, most of the evidence is from Europe, and UK constitute 50% of the papers which might limit the generalisability of the findings to high income countries. While the primary focus was to address the varied roles of carers in medication management, the outcomes for carers and care-recipients were considered secondary and linked broadly to their experiences in each role as possible. Obtaining and sharing information activities tended to be incorporated as part of care-recipient disease management information. Therefore, it was difficult to identify discrete information about medication-related information across some studies.

This review contributes to knowledge around understanding the current roles and needs of carers and people with LTCs around medication management. Further work is needed to evaluate carers lived experiences in undertaking medication management roles and related activities. A preliminary step towards identifying supportive mechanisms for carers is to appreciate carers roles and needs. Carers and health care providers perspective can inspire successful caregiving experiences and better services utilisation. An initiative to establish network channels between carers and health care providers could be discussed.

Conclusion

The results of this review showed that informal carers contribute to the medication management process in the community for people with LTCs. They provide interlinked activities that can require frequent adaptations. Health care providers need a mechanism to better support carers in these activities, outline their involvement and address their needs in their caring role. Hearing carers' voices is vital to developing the best recommendations and guidance for carers' involvement and support to allow them to better provide care in medication management in a safe and effective manner without overburdening the carer.

Author contributions: All authors contributed to the design, development and drafting of this manuscript. Conceptualization, MA, LL and CR; validation, MA, LL and CR; formal analysis, MA, LL and CR; investigation and resources, MA, LL and CR; data curation, MA, LL and CR; writing original draft, MA; writing—review and editing, MA, LL and CR; supervision, LL and CR; funding acquisition, MA. All authors have read and agreed to the published version of the manuscript. This systematic review was part of MA's PhD project. The guarantor is the primary PhD supervisor CR; accept full responsibility for the finished work and/or the conduct of the study, had access to the data and controlled the decision to publish.

Conflict of interest: No conflict of interest.

Data availability: All data supporting the findings of this systematic review can be found within the main article and/or the supplemental material document.

Ethics: This study does not involve human participants, and ethical approval was not required as it is a systematic review.

Patient and public involvement: No patient and/or public involvement.

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Figures legend	
Figure 1. PRISMA flow diagram.	
Figure 2. Medication management roles.	




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Supplemental material 1 A) PRISMA -Abstract o	checklist	right, including	
Section and Topic	ltem #	Checklist item	Reported (Yes/No)
TITLE		es e	
Title	1	Identify the report as a systematic review.	Yes
BACKGROUND		6000 dno t	
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the reverses.	Yes
METHODS	•		
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	Yes
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databases, registers) used to identify the information sources (e.g. databas	Yes
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	Yes
Synthesis of results	6	Specify the methods used to present and synthesise results.	Yes
RESULTS			
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.	Yes
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of in under d studies and participants for each. If meta-analysis was done, report the summary stighte and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).	Yes
DISCUSSION			
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the revealed in the rev	After the abstract
Interpretation	10	Provide a general interpretation of the results and important implications.	Yes
OTHER			
Funding	11	Specify the primary source of funding for the review.	N/A
Registration	12	Provide the register name and registration number.	After the abstract

B) PRISMA	-Report	checklist	
Section and Topic	ltem #	Checklist item	Loc whe rep
TITLE			
Title	1	Identify the report as a systematic review.	
ABSTRACT		aner 202	
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
INTRODUCTIO	N		
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped the syntheses.	
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other source searched or consulted to identify studies. Specify the date when each source was last searched or consulted to identify studies.	
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	(Su m
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 and each report, and if applicable, details of automation tools used in the process.	
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 confined ing data from study investigators, and if applicable, details of automation tools used in the process.	
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, and if not, the methods used to decide which results to collect.	
	10b	List and define all other variables for which data were sought (e.g. participant and intervent on the sources). Describe any assumptions made about any missing or unclosure information.	(Su m

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		BMJ Open Solution Sol	Page 2
Section and Topic	ltem #	Checklist item	Location where item is reported
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.	6-7 (Supplemental material 4)
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.	N/A
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e. the plane study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	7
	13b	Describe any methods required to prepare the data for presentation or synthesis, such a bandling of missing summary statistics, or data conversions.	7
	13c	Describe any methods used to tabulate or visually display results of individual studies and theses.	7
	13d	Describe any methods used to synthesize results and provide a rationale for the choice and stical was performed, describe the model(s), method(s) to identify the presence and extent obstatistical heterogeneity, and software package(s) used.	7
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arsing from reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for a boutcome.	N/A
RESULTS		gie. ie.	
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	7
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	7
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		copyrigh	
Section and Topic	ltem #	Checklist item	Loc wh rep
Study characteristics	17	Cite each included study and present its characteristics.	(Su n
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	(Su
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where and private) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using struct red tables or plots.	
Results of	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contrib	
syntheses	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present ach the summary estimate and its precision (e.g. confidence/credible interval) and measures of trical heterogeneity. If comparing groups, describe the direction of the effect.	
	20c	Present results of all investigations of possible causes of heterogeneity among study res	
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synteriated results.	
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outco	
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	
	23b	Discuss any limitations of the evidence included in the review.	
	23c	Discuss any limitations of the review processes used.	
	23d	Discuss implications of the results for practice, policy, and future research.	
OTHER INFORM		8 	
Registration	24a	Provide registration information for the review, including register name and registration nugber, or state that the review was not registered.	

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Section and Topic	Item #	Checklist item	Location where ite reported
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	3
	24c	Describe and explain any amendments to information provided at registration or in the are good	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the අගියි හි ponsors in the review.	14
Competing interests	26	Declare any competing interests of review authors.	14
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: temp算音ata collection forms; data extracted from included studies; data used for all analyses; analytic code; ar 如言情。 used in the review.	14
		raining, and similar technologies.	

Supplemental material 2: Search strategies

A) Medline search strategy

Ovid MEDLINE(R) and In-Process, In-Data-Rev	iew & Other Non-Indexed Citations <1946 to February 2. 2024>
Facets	Key terms
Long term condition(s)(LTC)	1 chronic disease/ or noncommunicable
	diseases/
	2 "chronic illness*".ab,ti.
	3 "chronic disease*".ab,ti.
	4 "chronic condition*".ab,ti.
	5 NCD*.ab,ti.
	6 "noncommunicable disease*".ab,ti.
	7 "non-communicable disease*".ab,ti.
	8 "noncommunicable illness*".ab,ti.
	9 "non-communicable illness*".ab,ti.
	10 "long-term disease*".ab,ti.
	11 "long-term illness*".ab,ti.
	12 "long-term condition*".ab,ti.
	13 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or
	10 or 11 or 12
Medication management (MM)	14 medication therapy management/
	15 Medication management.ab,ti.
	16 Medicines management.ab,ti.
	17 Medicines*.ab,ti.
	18 Medication*.ab,ti.
	19 14 or 15 or 16 or 17 or 18
Informal carers (ICs)	20 Caregivers/
	21 Informal carer*.ab,ti.
	22 Caregiver*.ab,ti.
	23 Carer*.ab,ti.
	24 Care giver*ab,ti.
	25 Family.ab,ti.
	26 Family caregiver*.ab,ti.
	27 Relatives.ab,ti.
	28 friend*.ab,ti.
	29 exp parents/
	30 parent*.ab,ti.
	31 grandparent*.ab,ti.
	32 spouse*.ab,ti.
	33 20 or 21 or 22 or 23 or 24 or 25 or 26 or
	27 or 28 or 29 or 30 or 31 or 32
2013	34 13 and 19 and 33

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B) Embase search strategy

Embase <1974	to 2024 February 02>
Facets	Key terms
Long term condtion(s) (LTC)	1 chronic disease/ or non communicable
	disease/
	2 "chronic illness*".ab,ti.
	3 "chronic disease*".ab,ti.
	4 "chronic condition*".ab,ti.
	5 NCD*.ab,ti.
	6 "noncommunicable disease*".ab,ti.
	7 "non-communicable disease*".ab,ti.
	8 "noncommunicable illness*".ab,ti.
	9 "non-communicable illness*".ab,ti.
	10 "long-term disease*".ab,ti.
	11 "long-term illness*".ab,ti.
	12 "long-term condition*".ab,ti.
	13 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or
	10 or 11 or 12
Medication management (MM)	14 medication therapy management/
	15 Medication management.ab,ti.
	16 Medicines management.ab,ti.
	17 Medicines*.ab,ti.
	18 Medication*.ab,ti.
	19 14 or 15 or 16 or 17 or 18
Informal carers (ICs)	20 caregiver/
	21 Informal carer*.ab,ti.
	22 Caregiver*.ab,ti.
	23 Carer*.ab,ti.
	24 Care giver*.ab,ti.
	25 Family.ab,ti.
	26 Family caregiver*.ab,ti.
	27 exp parent/
	28 parent*.ab,ti.
	29 exp grandparent/
	30 grandparent*.ab,ti.
	31 exp spouse/
	32 spouse*.ab,ti.
	33 friend*.ab,ti.
	34 Relatives.ab,ti.
	35 20 or 21 or 22 or 23 or 24 or 25 or 26 or
	27 or 28 or 29 or 30 or 31 or 32 or 33 or 34
3496	36 13 and 19 and 35

C) PsycINFO search strategy

APA PsycINFO <1	1806 to January Week 5 2024>
Facets	Key terms
Long term condtion(s) (LTC)	1 Chronic Illness/
	2 "chronic illness*".ab,ti.
	3 "chronic disease*".ab,ti.
	4 "chronic condition*".ab,ti.
	5 NCD*.ab,ti.
	6 "noncommunicable disease*".ab,ti.
	7 "non-communicable disease*".ab,ti.
	8 "noncommunicable illness*".ab,ti.
	9 "non-communicable illness*".ab,ti.
	10 "long-term disease*".ab,ti.
	11 "long-term illness*".ab,ti.
	12 "long-term condition*".ab,ti.
	13 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or
	10 or 11 or 12
Medication management (MM)	14 Medication management.ab,ti.
	15 Medicines management.ab,ti.
	16 Medicines*.ab,ti.
	17 Medication*.ab,ti.
	18 14 or 15 or 16 or 17
Informal carers (ICs)	19 Informal carer*.ab,ti.
	20 Caregiver*.ab,ti.
	21 Carer*.ab,ti.
	22 Care giver*.ab,ti.
	23 Family.ab,ti.
	24 Family caregiver*.ab,ti.
	25 Relatives.ab,ti.
	26 friend*.ab,ti.
	27 parent*.ab,ti.
	28 spouse*.ab,ti.
	29 grandparent*.ab,ti.
	30 caregivers/
	31 exp parents/
	32 exp spouses/
	33 19 or 20 or 21 or 22 or 23 or 24 or 25 or
	26 or 27 or 28 or 29 or 30 or 31 or 32
501	34 13 and 18 and 33

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D) CINAHL search strategy

CINAHL		
Facets	Key terms	
Long term condtion(s) (LTC)	S1. (MH "Chronic Disease") OR (MH "Noncommunicable Diseases")	
	S2. TI ("chronic illness*" or "chronic disease*" or "chronic condition*" or "NCD*" or "noncommunicable disease*" or "non communicable disease*" or "non-communicable disease*" or "noncommunicable illness*" or "non-communicable illness*" or "non communicable illness*" or "long-term disease*" or "long- term illness*" or "long-term condition*") OR AB ("chronic illness*" or "chronic disease*" or "chronic condition*" or "NCD*" or "noncommunicable disease*" or "non communicable disease*" or "non-communicable disease*" or "noncommunicable illness*" or "non-communicable disease*" or "non-communicable disease*" or "noncommunicable illness*" or "non-communicable illness*" or "noncommunicable illness*" or "long-term disease*" or "long- term illness*" or "long-term condition*")	
	S3. S1 or S2	
Medication management (MM)	 S4. (MH "Medication Management") S5. TI (medication therapy management or medication management or medicines management or "Medicines*" or "Medication*") OR AB (medication therapy management or medication management or medicines management or "Medicines*" or "Medication*") S6. S4 or S5 	
Informal carers (ICs)	 S7. (MH "Caregivers") OR (MH "Parents") S8. TI ("Informal carer*" or "Caregiver*" or "Carer*" or "Care giver*" or "Family" or "Family caregiver*" or "Spouse*" or "Parent*" or "Friend*" or "Grandparent*") OR AB ("Informal carer*" or "Caregiver*" or "Carer*" or "Care giver*" or "Family" or "Family caregiver*" or "Spouse*" or "Parent*" or "Friend*" or "Grandparent*") S9. S7 OR S8 	
1 003	510 S3 and S6 and S9	

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E) Web of Science search strategy

Web o	f Science
Facets	Key terms
Long term condtion(s) LTC	 TS=("chronic illness*" OR "chronic disease*" OR "chronic condition*" OR "NCD*" OR "noncommunicable disease*" OR "non communicable disease*" OR "non-communicable disease*" OR "noncommunicable illness*" OR "non-communicable illness*" OR "non communicable illness*" OR "non communicable illness*" OR "long-term disease*" OR "long-term illness*" OR "long-term condition*")
Medication management (MM)	 TS=("medication therapy management" OR "medication management" OR "medicines management" OR "Medicines*" OR " Medication*")
Informal carers	 TS=("Informal carer*" OR "Caregiver*" OR "Carer*" OR "Care giver*" OR "Family" OR "Family caregiver*" OR "Spouse*" OR "Parent*" OR "Friend*" OR "Grandparent*")
1924	4. 1 and 2 and 3
Scopus search strategy	
(TITLE-ABS-KEY ("chronic illness*" OR "chron	ic disease*" OR "chronic

Scopus search strategy F)

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(TITLE-ABS-KEY ("chronic illness*" OR "chronic disease*" OR "chronic
condition*" OR "NCD*" OR "noncommunicable disease*" OR "non communicable
disease*" OR "non-communicable disease*" OR "noncommunicable illness*" OR "non-
communicable illness*" OR "non communicable illness*" OR "long-term disease*" OR "long-
term illness*" OR "long-term condition*") AND TITLE-ABS-KEY ("medication therapy
management" OR "medication management" OR "medicines
management" OR "Medicines*" OR " Medication*") AND TITLE-ABS-KEY ("Informal
carer*" OR "Caregiver*" OR "Carer*" OR "Care giver*" OR "Family" OR "Family
caregiver*" OR "Spouse*" OR "Parent*" OR "Friend*" OR "Grandparent*"))

Supplemental material 3

A) Studies characteristics

#	Authors	Year	Country	Methodology	Study design
1	Alhaddad et al.	2016	UK	Qualitative study	Semi structured interviews
2	Bernhard <i>et al.</i>	2017	Germany	Qualitative sub-study	Focus groups
3	Bieri <i>et al.</i>	2021	Switzerland	Qualitative study	Semi-structured interviews
4	Conor <i>et al.</i>	2021	USA	Qualitative sub-study	Semi-structured interviews
5	Francis <i>et al.</i>	2002	UK	Qualitative study and quantitative analysis	Structured interviews
6	Garfield <i>et al.</i>	2021	UK	Qualitative study	Semi-structured interviews
7	Goldstein <i>et al.</i>	1996	UK	Qualitative study	Unstructured interviews and three group discussion
8	Kaasalainen <i>et al.</i>	2011	Canada	Qualitative study	Grounded theory
9	Lang et al.	2015	Canada	Interpretive description and multiple methods	Semi-structured interviews and focus groups
10	Look <i>et al.</i>	2018	USA	Qualitative study	Focus groups
11	Maidment <i>et al.</i>	2017	UK	Qualitative study	Semi-structured interviews
12	Mickelson <i>et al</i> .	2018	USA	Qualitative sub-study	Interviews
13	Rai <i>et al</i> .	2018	Canada	Qualitative study	Focus group
14	Read <i>et al.</i>	2018	UK	Qualitative study	Semi-structured interviews and ground theory
15	Ruark <i>et al.</i>	2024	Malawi	Mixed-methods observational study- sub-study	In-depth qualitative interviews
16	Smith <i>et al.</i>	2003	UK	Qualitative study and quantitative analysis	Structured interviews
17	Smith <i>et al</i> .	2015	UK	Qualitative study	Semi-structured interviews
18	Tan <i>et al.</i>	2023	UK	Qualitative study	Semi-structured interviews
19	Tomlinson <i>et al.</i>	2020	UK	Qualitative study	Semi-structured interviews
20	Tu et al.	2021	China	Qualitative study	Focus groups followed by in- depth interviews

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B) Data extraction*

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В)	Data extrac	tion*					r copy	
Authors/Ye ar & Origin	Aim	Study design/ Methods	Sample size / Participants	Care-recipients' long-term conditions	Carer-recipients' dyads	Key fi Medication management related activities	indings	Study limitations
Alhaddad et al. (2016) UК	To identify the roles and perspectives of carers assisting such patients, and to inform strategies that will enable healthcare professionals to support carers in their roles, reduce carer burden and optimise health outcomes.	Qualitative study Semi structured interviews	 Informal carers (n=14) Mean age of 61 (26-79) years. Sample included 10 Female and 4 males. 	People with chronic obstructive pulmonary disease (COPD), prescribed: nebules/respules and/or combivent (ipratropium and salbutamol) for use with a nebuliser in their home.	Family carers •Eleven spouses. •Three daughters. •All living with the care-recipient.	Ordering. Collecting. Maintaining supply. Nebuliser-related activities including setting up, cleaning, operating, purchasing and repair disposable parts of nebuliser. Administration. Monitoring and tracking. Medication-related information: obtain information. Decision -making.	•Ranged from full respectibility providing help with some spectra required. •Ranged from full respectibility solution required. •Ranged from full respectibility solution February 2025. Dow For uses related to te	 The sample was confined to 15 people who identified themselves carers. Carers who provide only limited assistance (which could be vital to patie care) did not consider themselves eligib and were therefore excluded. Carers from residential homes or other community day care services w have responsibility for patients, and who may face different challeng were not included. It is also possible that carers experiencing the highest levels of burd were not well represented in this study, being reluctant to participate d to time constraints.
Bernhard et al. (2017) Germany	To investigate the challenges and strategies of patients with type 2 diabetes mellitus (T2DM) regarding daily management of their medication regimen focusing on the role of them support networks.	Qualitative study Focus groups	People with type 2 diabetes(n=25) Participated in 4 focus groups - conducted with 6 to 8 German or Turkish speaking participants per group.	 People with type 2 Diabetes (T2DM), using (oral hypoglycaemic agents and/or insulin) Mean age of 64 ± 8.6, (49- 77) years Patients have other Long- term conditions (LTC) such as hypertension, arthritis, coronary heart disease. Mean number of other LTCs 3.4 ± 1.6, 1-7. Some patients receive Complex medication regimens (25). 	 Social resources (family/ Relatives friends). Professional friends (e.g., doctors). Peers. Half were living in partnership (56%, n = 14). 	Preparation and organisation. Administrations. Medication-related information: obtaining and sharing information. Monitoring and tracking.	Receive direct assistance. Lack support. Patients emphasised there of the offerse mining, Al training, and effects.	 •As participants opted in to the focus groups, they may have a great interest in medication self-management and may represent the perspectives of more active patients. • About half the patients were members of self-health groups (SHGs). we do not know the perspective of potential participants who chose not participate. Incorporating their experiences may have generated a ful picture of the situation.
Bieri et al. (2021) Switzerland	To explore and analyse polymedicated home- dwelling older adults personal beliefs about and stances on their medication prescriptions. We do this from the starting position of their daily medication practices and the perceptions of the HPs who look after them.	Qualitative study Semi-structured interviews	Older adults'(OAs), health care providers and informal carers. Older adults'(OAs) individual 2 interviews (n=28) mean age 81.1 (66-94) years old. Health care providers individual interviews (n=13) mean age 43.8 (28-58) years old - including four pharmacists/assistant pharmacists/assistant pharmacists/assistant pharmacists/assistant explain the explain of the explain older adult and the informal carers old Different number of ICs and OAs because some OAs did not had ICs.	 Polymedicated older adults Managing at least 5 different medications Mean number of medicines 9.0 range [5–21]. 	 Spouse/partner(n=10). Daughter-in-law(n=1) Children aged 18 and above (n=6). 	 Preparation and organisation. Administrations. Reminding. Medication-related information: obtaining information. Monitoring and tracking. 	Informal carers were not always involved in medication management, and the trip not always agree to participation Some OAs expressed their withes not to be particularly involved in the information about their polypharmacy. Tome ere expressed their refusal to geopo involved in case they. Informal carers who are the childrepoon OAs generally take this stance and weilow any and all information about the medication prescription that might be useful. Bibliog graphic Bibliog graphic in graphic in graphic	 The protocol involved the plan to systematically recruit one HP for ea OA interviewed. However, this provint impossible for reasons of unavailability. For some HPs, mainly general practitioners, our research objective with not a priority, although each OA designated the main involved in their polypharmacy management. Working in the context of pandemic compromised participant recruitment due to the vulnerability our population of interest. COVID-19 and social distancing recommendations also compromises scheduled home visits, and two HPs and one OA had to be interviewed telephone.

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 Findings are limited to a small sample of English-speaking careginolder adults in one urban city who were contending with MC multidrug regimens. However, we purposefully included caregivers ta adults with high medication burden, as these caregivers are more liliassist with complex medication regimens. Furthermore, we enrolled caregivers actively engaged in a caregiving which may have prevented the observation of other potential typo Additionally, we only interviewed caregivers and did not obta perspectives of the older adults. The cross-sectional study design does not allow us to examinic caregivers assume new roles or how medication manage resonshibilities chance over time. 	•Active involvement (n= 6). •Peripherally involved (n=5). •Not Involved (n=7). •Not Involved (n=7).	 Preparation and organisation. Administration. Reminding Monitoring and tracking. 	 Spouse/Partner. Child (18 years and over). Other family member or friend The majority were the patient's spouse (40%) or adult child (44%). 	 People managing 23 chronic conditions and prescribed 25 medications. Mean age of 73 years (SD 6.4) and were managing an average of 5 chronic conditions and 7 daily medications. 	Informal carers (n=24) •Eighteen carers were independent without assistance from paid carers. •Mean age of 61 years (SD 12.5); 68% were female (68%).	Qualitative subset study Semi-structured interviews	To characterise caregiver medication assistance for older adults with multiple chronic conditions.	Conor <i>et al.</i> (2021) USA
 Only those carers whose assistance involved the collection of prescri were eligible for inclusion in this study. Some pharmacists p prescription delivery services to clients, and, therefore, carers wit these services and provide medication-related assistance in the would not have been identified female carers were more likely to ap aparticitate the proportion of female carers (F1S) 	•The extent of involvement (provide the provident provid	Ordering. Collecting. Maintaining equipment. Maintaining supply. Buying medication or other remedies. Prenarting and remainstings	Caring for: • Mothers (n=50) • Father (n=12) • Mother in law (n=13) • Father in law (n=2) Both mother and father (n=3)	 Population aged over 65 years, belonging to ethnic minority groups and socio- economic status. 	Informal carers (n=184) 61% of the carers were female, aged between 18 and 81 year (mean 55 years) and the male carers represent 3% aged hetween 20 and 81	Qualitative study Structured interviews & Quantitative analysis	To document the roles and responsibilities of informal carers in the management of medication for older care, recipients the	Francis et al. (2002) UK
paracipate, are proporten of remote carers (or A).	2- Joint approaches: shared Xsom Sister for the management of medication of a 3- full responsibility by the card for the management of medication The number of medication and the activities undertaken by each and the the from one to 10.	Administration. Administration. Arminding. Medication-related information: obtaining and sharing information. Decision-making. Monitoring and tracking.	 Husband (n=35) Wife (n=47) Grandmother (n=2) Friend (n=9) Neighbour (n=3) Other relatives (n=6). Partner (n=2). 	De	years (mean 65 years).		extent to which specific activities are undertaken and to relate these to carers' coping and health.	
	 Assistance with adminigution gas sometimes formulation demodent. example, the administration of gas to the back or feet. This required inquest and regular attendance by the case when are 		10					
•Those people we did not reach may have experienced more diffi	•Varied based on the relat	•Ordering.	•Family, friends and/or community	●People shielding during the	•People with LTCs and	Qualitative cross-	To explore home	Garfield et
with their medicines during the pandemic. However, a survey carri- with people with disabilities reported those with a higher educationa level experiencing more difficulties with obtaining medicines durin pandemic. The reason for this remains unclear. •Despite our relatively large sample, new themes were cons-	family, friends and the community. June 14, 20	Collecting. Buying over-counter medications. Maintain supply. Medication-related information: obtaining.	networks.	COVID-19 pandemic and/or they were aged 70 years or more and were using at least one long-term medicine. •In the study the number of	corona virus (COVID-19) •Informal carers •Fifty people were interviewed (16 males, 34 females; mean age	sectional study Semi-structured interviews	medicine practices and safety for people shielding and/or over the age of 70 during the COVID-19	al. (2021) (UK) The study was carried out in two countries:
 emerging during data collection and we cannot be sure that our sampled to theoretical saturation. Despite efforts to increase the number of male participants, more fe than males participated; this may be because they were more likely to with others' medicines. These initial results are only from one country and may not support to the support of the sup	ies.			medicines being taken found to be ranged from 1 to 17.	 68 years, range 26–93 years). Nine reported having a more dominant role in helping manage medicines for another adult with 		pandemic and to create guidance, from the patient/carer perspective, for enabling safe medicine practices for	the UK and Ireland. This article presents findings from the UK.
generalisable elsewhere. The findings from Ireland, once available, w	e Bibliograf				managing their own medicines and focussed on their carer role during the interviews. Seven of these were female.		this population.	
	ohic				Ten were living slone			

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1 2 3 4 5 6 7 8 9 10 11	Goldstein <i>et</i> <i>al.</i> (1996) UK	To understand the nature of medication related assistance provided by informal carers and identify any problems with the medication role encountered by informal carers	Qualitative study unstructured interviews and three group discussion	•Informal carers (n=20) 2:1 ratio of female to male carer.	•Elderly people living in the community.	 Son or sister (n=2) Daughter(n=7) Husbands and wives formed the largest group of carers (n=11) Living situations were varied, thirteen were living with their dependent. 	Ordering. Collecting. Preparation and organisation. Administration. Reminding. Monitoring and tracking. Storage. Medication-related information: obtaining and sharing.	The type and level of indivenees is variable dependent on the returning of the returni	N/A
12 13	Kaasalainen	To explore the	A qualitative	Health care providers, informal carers and people	People with dementia using	Family carers	Preparation and organisation. Administration	Health care providers, carers the time to be t	 Including a volunteer sample that is based within one particular region, and only English-speaking participants. As such these findings might not be
14	Canada	related to medication	grounded theory to guide	with dementia.	maniple medications.	Neighbour.	Reminding.	dementia maintain their independence as	transferable to other settings or populations.
15		management of	data collection	•Fifty-seven interviews were			 Monitoring and tracking. 	very important. However, the vere aso	•Included only patients who had caregivers which was limiting to the
16		community-dwelling		completed			 Medication-related information. 	concerned about safety issuer relief	development of our model.
17		with dementia,		nurses(n=10).				•Depending on the degree of ementia and	
18		their informal		•Pharmacists (n=10).		\mathbf{N}		patients need and caregivers' availail	
19		caregivers and		•Family physicians(n=6).					
20		healthcare professionals who		Average age 47 years, 70% of them were woman.					
21		assist them. In		 Informal cares (n=20) mean 				, , ,	
22		particular, we sought		age of 65 years old women					
23		to understand the		(79%)				rai jo	
24		barriers and facilitators related to		People with dementia (n=11).				nin er	
25		managing their		Average age of				ıg, <mark>.</mark>	
26		medications		(69 years were mostly men				an 🤁	
27		at home and strategies		(64%).				d co	
28		and supports that are used to promote						sim Z	
29		medication adherence						ila on	
30		for older adults who						r te	
31		have dementia.						ine sch	
32	Lang et al.	To addresses the	Interpretive Description	•Seniors with chronic illness,	Seniors with chronic illness	Family carers:	•Ordering.	Diversity of engagement onged from	•The participants recruited for this study were required to have an unpaid
32	(2015)	medication	and multiple methods	family caregivers and paid		•Son.	•Collecting.	ongoing, active efforts to 00 evident	caregiver. This criterion eliminated the participation of many elderly
34	Canada	management issues	Semi-structured	providers.		•Wife.	Maintaining adequate supply.	activities.	individuals who were living at home alone, and who manage multiple
25		faced by seniors with	interviews and focus	 Seniors receiving home care services(n=32) 		•Granddaughter	Preparation and organisation. Administration	•Engaging in shared accountability	eAlthough the sample was somewhat diverse, it was limited to participants
26		illnesses, their family,	8.0055	•Family/caregivers (n=33)		•Friend	•Storage.	unique for every household and prir	who could speak either English or French.
30 27		caregivers, and paid		Paid providers(n=29)		 Neighbour 	Medication-related information:	respective health care teams.	•Qualitative researchers must be mindful of the possibility of participants
3/		providers within		•A total of 94 participants			obtaining and sharing information.	nc	providing responses they believe the interviewer is seeking rather than
38		canadian publicly		were interviewed			 Monitoring and tracking. 	Ф	reporting their actual experience.
39		programs in Alberta		•In addition, 69 providers				Bib	
40		(AB), Ontario (ON),		took part in focus groups.				lio	
41		Quebec (QC) and Nova						gra	
42		Scotia (NS).						ph	
43								iqu	
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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Look <i>et al.</i> (2018) USA	To explore how informal caregivers manage medications for their older adult care recipients by identifying the activities involved in medication management and the tools or strategies used to facilitate these activities.	Qualitative study Focus groups	•Informal carers (n=29) mean age 67 (42 to 85) years.	Older adult aged 65 years or older. mean age 85 (65 to 106) years. individual with dementia (n=10 out of 29). •Approximately 80% of the caregivers managed 5 or more medications and 31% managed 10 or more.	Caring for: •Spouse (n = 14) •Parent or parent-in-law (n = 11) •Others (n=4) •Length of care: 2 -12 month.	Direct medication management activities (requiring physical handling): Ordering and picking up medications. •Splitting or cutting pills. •Organisation. •Administration. •Assistance, teaching and monitor to use several devices including: inhalers, nebulisers, nasal sprays, blood pressure machines, diabetic test strips, and anticoagulation monitoring. •Reminding. • Storage. Indirect medication management activities (requiring cognitive efforts): • Organise and keep track of medications. • Informational support. • Interact with the health care system.	Caregiver involvement in direct activities varied depending on the caregivers is assisting relative independent individuals. proved assistance with as few as the of relative caregivers assisting relative assistance with as few as the of relative activities. Some indirect activities were cantered on interactions with various measures of re- health care system, which included doops, nurses, pharmacies, health ca cate to text are related to text are to text are	 Sample size was small with only 29 caregivers in 4 focus groups within one rural county. Subjects were selected for convenience and focus groups were not continued until saturation was achieved. In addition, due to the use of a convenience sampling approach, an accurate response rate could not be determined. Differences between caregivers, including generational differences, living situation, and care recipient health status were not addressed. caution should be used in generalising the findings to a wider population of caregivers, as the participants may be more engaged or interested in medication management than non-participants. Compared to the national caregiving population, our sample had older caregivers and care recipients, more females, A higher prevalence of care recipient dementia, and managed a higher number of medications Care recipients with specific physical and mental health conditions may require specific medication management activities. The medication management needs associated with specific illnesses or conditions were not addressed in this study.
 16 17 18 19 20 21 22 23 24 25 26 27 28 	Maidment et al. (2017) UK	To describe and understand the key challenges, in relation to medication issues, experienced by people with dementia and their informal carers dwelling in the community, and the potential role of community	An exploratory qualitative study design semi-structured interviews	 Informal carers, people with dementia and health care providers. Informal carers (n=11) People with dementia (n=4) Health care providers (n=16) (four GPs, five nurses, three social care professionals [paid formal carers] and four community pharmacists), were interviewed. 	People with dementia	Not specified	Ordering. Collecting. Tracking medication supply. Preparation and organisations. Administration. Medication-related information: obtaining. Decisions-making	Person with dementia very the process. Person with dementia very the process. Person with dementia very the process. In the care. Person with dementia very the process. In the process. In the process.	 Findings are context-bound to the participants and study setting, like all qualitative research. Although we believe that the testimonies from the participants were particularly rich in content, as data were obtained from face-to-face interviews, we cannot avoid the possibility that participants may have given socially desirable responses. Only a limited number of participants from the Black and Minority Ethnic (BME) community were interviewed.
29 30 31 32 33 34 35 36 37 38 39 40	Mickelson et al. (2018) USA	pharmacists. The purpose of this study was to investigate medication safety through the analysis of non-adherence events described by older patients with heart failure, a chronic illness associated with multiple medication use	Cross sectional data collected by qualitative study- interviews	 People with heart failure and informal carers. People living with heart failure (n=61). Mean age 73.31 (6.73, 65–86). Informal caregivers (n=30). 	People with heart failure Patients regimens included a median of 16 medications (Mean=16.1, SD = 5.54) administered between one and six times per day.	Family carers •Spouse (33) •Sibling (7) •Adult child/grandchild (2) 19 lived alone.	 Preparation and organisation. Administration. Monitoring and tracking. Medication-related information: sharing. Decision-making. 	Absent, delayed, or princomate communication, information draining, and coordination of activities were factored some events. Social support from inform caregories was not always available, during caregories 'work hours. Inadequate social support from caregories enabled error events.	 The data used for this analysis was gathered from a larger study of heart failure self-care, with only a subset of data collection methods designed to measure medication-related events. Performance-shaping factor were extracted from narratives, rather than from structured assessment instruments, and we did not use a specific error/incident taxonomy because none applied directly to this domain; however, our PSF categories and their definitions were based on prevailing systems models and incident taxonomies.
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Page	39 of 47	,				s/bmjo cted by			
1 2 3 4 5 6 7 8 9 10 11 12	Rai <i>et al.</i> (2018) Canada	To explore inflammatory arthritis (IA) patients' perspectives on tools and strategies to support chronic medication use using an interactive focus group activity.	Qualitative study Focus group	•Patients with inflammatory arthritis(n=27) Six focus group interactions with a total of 27 participants, including 17 women and 10 men. Age range (20-79) years.	Rheumatologist-confirmed diagnosis of IA, currently taking medication. Aged 19 and over. (eg, disease modifying anti- rheumatic drugs [DMARD])	Family carers •Spouse •Mother	Administration. Reminding.	oen-2024-094443 on 25 February 2025 Enseignem copyright, including for uses related ×	 Participant recruitment primarily took place in the metropolitan city of Vancouver; however, those living in rural communities were also invited to participate through phone or videoconference. Voluntarily participated in our study may be more likely to use their medications as prescribed and thus might not reflect the perspectives of "non-adherent" individuals.
13 14								to to	
 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 	Read <i>et al.</i> (2018) UK Ruark <i>et al.</i> (2024) Malawi	Few studies have examined the effect of dementia on medication management strategies for glaucoma including how patient and carer needs impact adherence and long- term prognosis. We report findings from a qualitative grounded theory study incorporating the views of patients, carers, and healthcare professionals.	Qualitative study Semi-structured interviews. Ground theory Mixed-methods observational study including: in-depth qualitative interviews	 Patients and informal carers when attending the glaucoma clinic with the patient. Health care providers. Cohort A: Patients with glaucoma and dementia (n=23). Carers (n=22). Health care providers (n=9). Cohort B Patients with glaucoma only (n=6). Cohort C Patients with glaucoma and other non- dementia comorbidity (n=6). From the total of 66 participants, 17 patients with dementia and glaucoma were interviewed twice in 6 months. Overall, this generated 83 semi structured interviews. Twenty-five couples (50 individuals). Females mean age 47.6 5D (S.8). 	Main condition glucoma and dementia. Some patients found to have a Secondary condition type Aortic stenosis Chronic back pain Diabetes Diverticulitis Main condition HIV • Other condition including diabetes and hypertension.	Family carers Aged 50-90 years old; three quarters of those in the lay caring role were female. •Spouse •Adult children	 Reminding. Administration. Monitoring and tracking. • Collecting. Reminding. Medication-related information: sharing. 	Active accepters what patients independent and able that are period off- management of medication. A second s	 The study was limited to patients with mild dementia able to provide their own informed consent. Small sample size. Small sample size. •Men and particularly women living with diabetes were underrepresented in the sample, and we may not have reached saturation regarding the particular challenges of living with diabetes. •Participants may have represented their marriages and behaviours in cocially deciable wave a though a consist on for context are provided.
36 37 38 39 40 41 42 43 44 45		the health of people living with cardiometabolic disorders and HIV.	interviews.	(7.0).	peer review only	- http://bmjopen.bm	j.com/site/about/guide	Acare man any to be involved in the human's medical care but met resisting . A carer wife spoke at length about we her husband failed to support her whether was ill. Additional non-spousal support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support her whether was ill. Additional non-spousal support was room of the spoke at length about we her husband failed to support her whether was ill. Additional non-spousal support was room of the spoke at length about we her husband failed to support her whether was ill. Additional non-spousal support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support we her husband failed to support was room of the spoke at length about we her husband failed to support was room of the spoke at length about we her husband failed to support wa	social desirable ways, annough comparison of couples accounts provided some indication of the veracity of their descriptions (when couples' accounts converged) or the presence of social desirability bias (when couples' accounts diverged).

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•The recruitment rate of 25% is low, and therefore, caution must exercised in generalising the findings to a wider population of carers older people in a primary care setting, the sampling procedures w designed to reflect diversity in patterns of medication-related proble experienced by this group.	 performance Carers providing different legopyright, including for uses related Carers providing to the set of the s	 Ordering. Collecting. Maintaining adequate supply. Check prescriptions. Buying over-the counter medications. Preparation and organisation Administration. Reminding. Monitoring and tracking. Medication-related information: obtaining and sharing. Decision-making 	 Eighty-five carers (46%) were caring for spouse/partner, Looking after a parent/parent-in-law (n=79) (43%) Assisting a different relative, friend or neighbour (n=20) (11%). No other informal carer (n=103) (56%) Lived with the care recipient (n=120) (65%). 	•Elderly with polypharmacy. •The median number of prescribed medications which care recipients were taking was five (range = 1-19). •Common medication indications: cardiovascular (n = 69 care recipients, 74%), central nervous system (n= 48, 52%) and gastro-intestinal (38, 41%) problems. they used different pharmaceutical formulations such as tablets, liquids, creams and inhalers	•Elderly with polypharmacy and informal carers. •Elderly with polypharmacy(n=93). Mean age of care recipient 74(60–106) •Informal carers (n=184) Mean age of ICs 65 (30–91). Female carers mean f 54.8 years compared with 64.6 years for male carers.	Qualitative study Structured interviews & Quantitative analysis	To report the number and type of problems experienced by informal carers when managing medication for older care recipients, and to relate these to measures of coping and health.	Smith <i>et al.</i> (2003) UK
• This study was limited in that it involved just a small number of carers fr one part of London. Although the needs and perspectives of family car in assisting with medicines may be replicated elsewhere, differences, e.g service provision, may affect carers' experiences.	•Dependency on carer were vor each state of the state of	Ordering. Collecting. Maintain adequate supplies. Preparation and organisation. Administration. Reminding. Monitoring and tracking. Medication-related information: obtaining and sharing. Decision-making.	Family carers •Daughters(n=10). • Sons(n=2). •Husband(n=1). •Wife(n=1). •Five_carers_lived with the care- recipient.	Dementia living at home including cardiovascular disease, respiratory problems, osteoporosis, joint pain and mental health problems. People were found to take medication ranged from1 to 15 (mean 7).	 Informal carers Fourteen interviews conducted with carers aged from 45 to 86 years including eleven female and 4 males. People with LTCs Five interviews conducted with people aged from 81 to 93 years all of them were female. 	Qualitative study Semi-structured interviews	To examine the scope and range of medicines-related assistance provided by family carers of people with dementia, the problems that arise and to identify how service provision could become more responsive to these needs.	Smith <i>et al.</i> (2015) UK
 The small number of participants representing each characteristic methat not all experiences of treatment burden may have been captur However, there were several limitations. Firstly, this study was conducted in the UK with a publicly funded natio health system and the findings may not apply to PwP and caregivers in ot countries with different health systems, although they are likely experience similar challenges worldwide. Secondly, there was a lack of ethnic diversity among participants whe may limit the transferability of the findings, although this aligns with local population of the study region. Thirdly, data regarding financial capacity or deprivation levels were collected and these factors may influence the experiences of participants with PD who did not respond to the study invitation were a 67–87 years old, diagnosed with PD between 1–23 years, living alone cohabiting, with or without a caregiver, and two PwP who had e cognitive impairment. Whilst these were similar characteristics participants recruited in this tudy, participants with high treatment bur or less capacity may not have consented to participate in the interviews to the limited time constraints in their everyday lives trying to manage ti PD. Therefore, there may be other aspects of treatment burden capacity not reported in the findings. 	People with Parkinson's rend on meir caregivers or friends to competentise this sk as they were unable to use competent themselves due to tremorial had door memory, and experienced mobility issues. Bibliographic	 Ordering. Collecting. Getting prescriptions right. Preparation and organisation. Reminding. Monitoring and tracking. Medication-related information: obtaining. Decision-making. 	Family carers •Wife(n=10) • Husband (n=2) •Sister(n=1). •Daughter(n=2). Others: • Friends. • Neighbours • Church members •Parkinson's UK support groups. • Peers. No carer (n=2)	People with Parkinson's disease (PwP) including dementia. <u>All lived their home.</u> <u>Three living alone.</u>	People with Parkinson's and informal carers. People with Parkinson's (n=9) aged 59–84 years. informal carers (n=8).	Qualitative study Semi-structured interviews.	To explore the experiences of treatment burden and capacity among patients with Parkinson's disease and their caregivers and identify potentially modifiable factors.	Tan et al. (2023) UK

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1 2 3 4 5 6 7 8 9 10 11 12	Tomlinson et al. (2020) UK	To explore the experiences of older patients and their family carers as they enacted post- discharge medicines management, focusing on identifying what helps and hinders them.	Descriptive qualitative study Semi-structured interviews.	Older adults and informal carers. Older participants(n=27). <i>Female(n=21); mean age 84 years).</i> •Informal carers (n=9).	People aged 75 years or over; used five or more medicines; lived with LTCs (frailty and type 2 diabetes mellitus were used as exemplar conditions in this study); and had medicines change during their admission to hospital. Findings shows that All participants had at least one medication change or recommendation made about their medicines (mean 4.6 changes).	 Spouse. Daughter. Living arrangement: lived with Spouses (n=9) Others(n=1) Living alone(n=19) Carers: No one (n= 6) (22%) Family (n=17) (63%) Combination of family and social services 1 (4%). 	 Helped with rationalise and monitor the stock of medicines and supply. Preparation and organisation. Reminding. Medication-related information: obtaining. 	 Few participants simply could of marge their medicines and relied of thers, thous as formal carers, to administrative medicines was often due to their seling to deteriorating memory or reduced capaby after discharge. One patient has 2 family cares. The level to which they maged in g for uses related these activities varied. 	•The sample was limited in its ethnic diversity and does not represent the wider population of the UK. It is therefore unclear whether the findings are transferrable to other patient groups and to the population as a whole.
13 14 15 16 17 18 19 20 21 22 23 24	Tu <i>et al.</i> (2021) China	To explore: i) how is the cause and management responsibility for diabetes appraised by older Chinese couples? ii) What are their main barriers in daily care activities? and iii) Is there any gender-specific pattern associated with diabetes management?	Qualitative study Focus groups followed by in-depth interviews	Four focus groups with 11 couples and 10 in-depth interviews with 10 couples Mean age of the couple were 67 years old.	Older couples aged 60+, where at least one partner had type 2 diabetes mellitus (T2DM).	Spouse	Reminding Monitoring and tracking.	Except for one couple, where the information of the same provided in the same provided i	 Sample was relatively small and was recruited through purposive sampling. The couples interviewed were likely to represent the younger- old, with a satisfying marital relationship. Our findings may underestimate the T2DM management challenges faced by the oldest-old and be biased towards positive spousal interactions and cooperative coping styles. Nonetheless, our findings about the interviewees' insufficient knowledge and management barriers may also hold true among older patients without spousal support and warrant further investigations to identify their dilemma regarding diabetes care considering their specific family context. Furthermore, we interviewed the couple dyad together to gain insights into their interactional processes. Although both spouses were encouraged to participate equally, the discussion was sometimes dominated by one spouse, and the other party may qualify their responses due to their partner's presence.
25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45	*Inforr	l mation was co	 pied and summ	l arised from the or	iginal reference; f	ior consistency, united	l d terms were used for equ oj.com/site/about/guidel	uivalent meaninggind similar technologies.	ields.

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4 5	Supple	mental material	4: Quality assessmen	it				, inclu				
6				Qualitat	ive analysis (n	=20)		Iding) i)			
/ 8		Screen	ing questions			Me	thodological quality cr	iteria 7	י ק			
9 10 11 12 13 14 15 16 17 18	Study	S1. Are there clear research questions?	S2. Do the collected data allow to address the research questions?	1.1. Is the qualitative approach appropriate to answer the research question?	1.2. Are qualitative collection methods adequate address research question?	the data to the	1.3. Are the findings adequately derived from the data?	ioruaty 2座25,のwinioaded inc Enseign诗mられ Superieur (A uses 座lated 天の 镜xt and data	Is the retation of sufficiently ntiated by	1.5. Is to coherence between qualitative sources, collection, analysis, interpretatio	there data and on?	Score*
19 20 21	Alhaddad <i>et al.</i> (2016) UK	Yes	Yes	1	0		1	BES) . mining, A	1	1		4
22 23 24 25 26	Bernhard <i>et al.</i> (2017) Germany	Yes	Yes	1	0		1	l training, an	1	0		3
27 28 29 30	Bieri <i>et al.</i> (2021) Switzerland	Yes	Yes	1	0		1	d similar to	1	1		4
31 32 33	Conor <i>et al.</i> (2021) USA	Yes	Yes	1	0		1	une 14, 202 echnologie	1	1		4
34 35 36 37 38	Francis <i>et al.</i> (2002) UK	Yes	Yes	1	0		1	S.	1	1		4
 39 40 41 42 43 44 45 			For peer revi	ew only - http://bmj	open.bmj.com/	/site/ab	out/guidelines.xhtml	sibilographique de l				

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2 3 4 5 6 7	Garfield <i>et al.</i> (2021) UK	Yes	Yes	1	0	1	1 24-094443 on 25 ight, including	1	4
, 8 9 10 11	Goldstein <i>et al.</i> (1996) UK	Yes	Yes	1	0	1	1 February 202 For uses relate	1	4
12 13 14 15 16	Kaasalainen <i>et</i> <i>al.</i> (2011) Canada	Yes	Yes	1	0	1	1 5. Downloade d to text and	1	4
17 18 19 20 21	Lang <i>et al.</i> (2015) Canda	Yes	Yes	1	0	1	1 ed from http:/ ur (ABES) . data mining,	1	4
22 23 24 25 26	Look <i>et al.</i> (2018) USA	Yes	Yes	1	0	1	1 Al training, a	1	4
27 28 29 30 31	Maidment <i>et al.</i> (2017) UK	Yes	Yes	1	0	1	1 .com/ on June nd similar tech	1	4
32 33 34 35	Mickelson <i>et al.</i> (2018) USA	Yes	Yes	1	0	1	1 14, 2025 at A nologies.	0	3
36 37 38 39 40	Rai <i>et al.</i> (2018) Canda	Yes	Yes	1	0	1	gence Bibliog	1	4
41 42 43 44 45 46 47			For peer revi	ew only - http://bmjo	pen.bmj.com/site/ab	out/guidelines.xhtml	ıraphique de l		

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- 3 4 5 6 7	Read <i>et al.</i> (2018) UK	Yes	Yes	1	0	1	ht, including f	1	1	4
8 9 10 11 12	Ruark <i>et al.</i> (2024) Malawi	Yes	Yes	1	0	1	February 202 Enseignei or uses relate	1	1	4
12 13 14 15 16	Smith <i>et al.</i> (2003) UK	Yes	Yes	1	0	1	5. Downloade nent Superieu d to text and	1	1	4
17 18 19 20 21	Smith <i>et al.</i> (2015) UK	Yes	Yes	1	0	1	id from http://t ur (ABES) . data mining, A	1	1	4
22 23 24 25 26	Tan <i>et al.</i> (2023) UK	Yes	Yes	1	0	1	omjopen.bmj.c J training, and	1	1	4
27 28 29 30 31	Tomlinson <i>et al.</i> (2020) UK	Yes	Yes	1	0	1	om/ on June ' I similar techn	1	1	4
32 33 34 35 36	Tu <i>et al.</i> (2021) China	Yes	Yes	1	0	1	ologies.	1	1	4
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3				Quantita	tivo analysis (n-2)		⊢094		
4 5		Screen	ing questions	Quantita		thodological quality cr	$\frac{1}{10}$ $\frac{14}{10}$		
6 7 9 10 11 12 13 14 15 16 17	Study	S1. Are there clear research questions?	S2. Do the collected data allow to address the research questions?	4.1. Is the sampling strategy relevant to address the research question?	4.2. Is the sample representative of the target population?	4.3. Are the measurements appropriate?	4. 45 the risk of 4.4. 45 the risk of 5.5 ponse bias 5.5 ponse bias 4.6 to the the text and da	4.5. Is the statistical analysis appropriate to answer the research question?	Score *
18 19 20 21 22	Francis <i>et al.</i> (2002) UK	Yes	Yes	1	0	1	from http://br (ABES) . (taymining, Al	1	3
23 24 25 26	Smith <i>et al.</i> (2003) UK	Yes	Yes	1	0	1	njopen.bmj.c træjning, and	1	3
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47			For peer revi	ew only - http://bmj	open.bmj.com/site/ab	out/guidelines.xhtml	om/ on June 14, 2025 at Agence Bibliographique de l similar technologies.		

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1 2 3 4 5 6							1-2024-094443 on 2 opyright, including				
7 8	Mixed studies (n=2) 약 교										
9		Screen	ing questions		Met	ite					
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26	Francis <i>et al.</i> (2002) UK Smith <i>et al.</i>	S1. Are there clear research questions? Yes	S2. Do the collected data allow to address the research questions? Yes	 5.1. Is there an adequate rationale for using a mixed methods design to address the research question? 1 	5.2. Are the different components of the study effectively integrated to answer the research question? 1	 5.3 Are the outputs of the integration of qualitative and quantitative components adequately interpreted? 1 	Are Start	 5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved? 1 	*aloos 4		
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47	(2003) UK *Score c (0-1= lov	nut of five. w quality; 2-3= me	edium quality; For peer revie	ew only - http://bmjo	ppen.bmj.com/site/abo	u out/guidelines.xhtml	mj.com/ on June 14, 2025 at Agence Bibliographique de l _S and similar technologies.		4		

	Pharmaceutical formulations								
Authors	Ear drops	drops	Inhalers	Injections	Nasal spray	Nebulisers	Oral	Sublingual	Topical
Alhaddad <i>et</i> <i>al</i> .(2016) [44]						~			
Bernhard <i>et al</i> .(2017) [34]				~			~		
Bieri <i>et al.</i> (2021)[41]		0,	-				~		
Conor <i>et al.</i> (2021) [33]							~		
Francis <i>et al.</i> (2002)[32]	✓	~		✓			~		✓
Goldstein <i>et</i> <i>al</i> .(1996) [37]		~					~		
Kaasalainen <i>et</i> <i>al</i> .(2011) [45]							~		
Lang <i>et</i> <i>al.</i> (2015)[43]				0			~		
Look <i>et al.</i> (2018)[46]		~	~	√		~	~		
Maidment <i>et</i> <i>al.</i> (2017) [47]					2		~		
Mickelson <i>et</i> <i>al.</i> (2018) [35]							~	✓	✓
Rai <i>et al.</i> (2018) [48]				✓		5			
Read <i>et al.</i> (2018) [49]		✓					V		
Smith <i>et al</i> . (2003)[31]			~				~		✓
Smith <i>et al.</i> (2015) [50]							~		

Supplemental material 5: Pharmaceutical formulations handled by carers. This data were extrapolated from the included studies via main text, quotes or examples.

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Supplemental material	6: Reminding tools
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	Reminder tools								
Authors	Alarm	Calander/ Checklist	In-person visiting	Notes	Phone call	Phone text	Routine markers	Verbal reminding	
Bieri <i>et al.</i> (2021) [41]	✓			~			√		
Conor <i>et al.</i> (2021) [33]	√				✓			~	
Francis <i>et al.</i> (2002) [32]	C						✓		
Goldstein <i>et al.</i> (1996) [37]							✓		
Kaasalainen <i>et</i> <i>al.</i> (2011) [45]		6		√					
Look <i>et al.</i> (2018) [46]	√	✓		√			~	~	
Rai <i>et al</i> . (2018) [48]						v			
Read <i>et al.</i> (2018) [49]		~		2	 ✓ 		~	√	
Ruark <i>et al.</i> (2024) [36].		1	1		N/A	1		1	
Smith <i>et al</i> . (2003) [31]	✓				2			√	
Smith <i>et al.</i> (2015) [50]			√		× (2			
Tan <i>et al.</i> (2023) [42]	✓						~		
Tomlinson <i>et al.</i> (2020) [38]		~							
Tu <i>et al.</i> (2021) [39]		N/A							