Kamarajah *et al.*
BMC Health Services Research (2025) 25:290
https://doi.org/10.1186/s12913-025-12424-2

BMC Health Services Research

RESEARCH

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Implementation of hospital-initiated complex interventions for adult people with multiple long-term conditions: a scoping review

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Summary

Background The increasing prevalence of multiple long-term conditions (MLTC) presents significant challenges to healthcare delivery globally. Although interventions for long-term conditions have predominantly been designed and evaluated in primary care settings, there is a growing recognition of the need to address the management of MLTC within secondary care. This scoping review aims to comprehensively evaluate hospital-initiated complex interventions for people with MLTC.

Methods We searched MEDLINE, Embase, PsycINFO, CINAHL Plus and Cochrane Library to identify published studies from Jan 1, 2010, evaluating hospital-initiated interventions initiated for adults (aged ≥ 18 years) with MLTC (PROSPERO: CRD42024498448). Studies reporting patients with frailty only, one long-term condition or orthogeriatric studies that did not focus solely on people with MLTC were excluded. The primary outcome measures were the characteristics of these complex interventions measured as: (i) intervention components, (ii) stakeholders involved; and (iii) implementation strategies, reported according to a theoretical framework (Expert Recommendations for Implementing Change). Secondary outcome measures were clinical and cost implications of these complex interventions, feasibility and sustainability, defined according to the World Health Organisation implementation framework.

Findings This scoping review identified 70 studies (56,111 participants). Twelve intervention components were identified in 52 combinations; the most common were medication review and optimisation (*n* = 39), chronic disease management (*n* = 34) and providing detailed care plans (*n* = 23). Majority of studies included two or more interventions components (*n* = 49) delivered by multiple stakeholders (*n* = 38). Of eleven implementation strategies reported, training and educating stakeholders, establishing integrated wards or clinics and regular multidisciplinary team meetings were the most common. Majority of combinations of intervention groups were associated with improved clinical outcomes for patients with MLTC (*n* = 43/70, 61.4%), yet eight studies reported on costs. However, embedding training and education or integrated clinics in delivering these intervention groups were associated with improved clinical outcomes, irrespective of the number of healthcare professionals involved. Majority of studies were evaluated in single centre settings, with limited evaluation of broader implementation measures.

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Interpretation Hospital-initiated complex interventions that involve multiple stakeholders may be feasible and appear to be clinically useful for people with MLTC. To strengthen impact and support wider scale-up across health systems, closing knowledge gaps around cost-implications and strategies to improve implementation of these complex interventions through training and education or integrated clinics will be crucial.

Keywords Multimorbidity, Multiple long-term conditions, Interventions, Quality of life

Introduction

One-in-four adults [1, 2] in the UK and four-in-ten adults [3] globally live with multiple long-term conditions (MLTC) or multimorbidity. In the UK, it is expected that the incidence and prevalence of multimorbidity will double or triple over the next decade [4]. This rapid growth poses considerable challenges to health and care systems worldwide [5], since current delivery of clinical services are often focussed on single disease, fragmented, and poorly coordinated, especially in secondary care [6]. At present, people with multimorbidity experience high rates of hospital admissions, poor quality of life in later years [7] and premature death compared to the general population [5]. This growing problem has led to calls for healthcare systems worldwide, across primary and secondary care, to identify solutions [7, 8].

The 2023 Chief Medical Officer's Report on Health in an Ageing Society identifies the need for all healthcare professionals to implement effective evidence-based interventions to improve outcome for patients with MLTC, including in secondary care settings. There is a growing evidence base around complex interventions to improve current pathways to improve outcomes for patients with MLTC. In primary care or community settings, the evidence stems from high-quality clinical trials [9] and systematic reviews of clinical trials [10–12]. In secondary care, there is a varying designs in which these complex interventions have been evaluated, from single-arm feasibility studies to randomised clinical trials. Published reviews to date have attempted to synthesise evidence combining interventions evaluated in either primary or secondary care pathways [11, 13–15] for people with MLTC. However, these reviews include a heterogenous population such as elderly or frail patients or those with one long-term health condition only. Therefore, applicability or effectiveness of these different complex interventions within secondary care systems remains unclear.

Although hospital-based interventions have been evaluated to address people with MLTC, the intervention components and strategies used to implement them have been poorly studied. Understanding these are important to enable researchers and policymakers to improve the replicability and implementation of the tested hospital-based interventions and optimise benefits. At present, there are no scoping reviews evaluating characteristics and clinical effectiveness of hospital-based interventions to address people with MLTC. Therefore, we aimed to provide comprehensive analysis of hospital-initiated complex interventions to improve outcomes for people with MLTC and inform delivery of evidence-based services into routine practice.

Methods

This was a prospectively registered scoping review (PROSPERO: CRD42024498448) and reported according to the Preferred Extension for Scoping Review (PRISMA-ScR) [16] guidelines (appendix p 4, Table S1). This scoping review was conducted according to the Cochrane Training for Scoping Reviews [17].

Objectives

The objectives of this scoping review were to:

1. To identify studies evaluating hospital-initiated complex interventions for people with MLTC
2. To describe the different types of hospital-based interventions and implementation strategies used
3. To provide a descriptive overview on the clinical- and cost-implications for the primary outcome measures evaluated in these studies.
4. To examine the completeness of reporting these complex interventions according to template for intervention description and replication (TIDieR) [18] checklist

Patient and public involvement

This scoping review had strong input from a patient and public involvement (PPI) group identified from the established AI for Multiple Long-term Conditions (AIM RSF). The PPI group included eight patients with lived experience of MLTC who have received care in hospitals to ensure the key conclusions drawn were meaningful and relevant. This PPI group, with a named patient lead (SB) were involved in the design of this scoping review protocol and interpretation of study findings. We also spent time discussing findings from the scoping review such as the interventions and outcomes with the PPI group, to understand relevance of these findings to them. They helped with placing these findings into context, which helped shape the discussion.

Selection criteria and search strategy

This scoping review included peer-reviewed studies evaluating complex interventions initiated in hospital settings for adults (aged ≥ 18 years) with MLTC. We included the following studies: (i) all studies done in high-, middle- and low income countries (as classified at the time of the search by the World Bank Group) [19] published since Jan 1, 2010, since healthcare systems change over time; (ii) experimental studies, both randomised and non-randomised study designs; and (iii) identifying hospital-initiated interventions since there have been several published scoping reviews have focussed on primary care or community settings, and processes in primary care or community are separate to secondary care systems. Although a few reviews have been published evaluating hospital-initiated interventions in secondary care settings, these have been narrative with little in-depth description around intervention components and strategies to implement them [15]. Hospital-initiated interventions were defined as interventions which were evaluated either in the outpatient or inpatient settings which may or may not extend into the community or primary care settings. Finally, we included studies where either majority of patients had MLTC or where the mean of long-term conditions was equal or greater than two, as this was the most pragmatic to maximise capture of relevant studies.

We excluded the following studies: (i) delivered primarily in primary care; (ii) studies reporting interventions in patients with frailty only, one long-term condition or orthogeriatric studies that did not focus solely on people with MLTC; and (iii) scoping reviews, systematic reviews or editorials. Studies reporting a cohort of patients with frailty only were excluded if there were no reporting of a cohort with MLTC. Although 70% of patients with frailty have MLTC, we did not want any assumptions to influence the data synthesis. A summary of the inclusion and exclusion criteria are presented (appendix p 5, Table S2). Searches were performed in MEDLINE (Ovid), Embase (Ovid), PsycINFO (Ovid), CINAHL Plus (EBSCO), and Cochrane Library to identify relevant studies from Jan 1, 2010 to March 30, 2024. The date the searches were undertaken were between 2nd April—4th April 2024. The search terms included multimorbidity or MLTC or chronic diseases, management, and secondary care. The full search strategy, developed with an information specialist, is shown in the appendix (p 6, Table S3). To supplement the database search, we hand-searched reference lists of any studies that we found (backward-citation searches) [20].

Study selection

Articles were uploaded to Covidence, which automatically removed duplicates. The study screening was delivered over a two-staged process by three independent reviewers (SKK, SL, NDS). In stage 1, the titles and abstracts were screened by three authors (SKK, SL, NDS); 30% of abstracts were double screened. Disagreements were resolved by consensus, and in the case that consensus could not be reached, the Study Management Group arbitrated. Once agreement was reached on the included studies, full-text articles of the remaining studies were obtained for full text review, which were independently assessed by two authors (SKK, SL).

Quality assessment

Methodological quality of the included studies was assessed independently by three reviewers (SKK, SL, NDS), with the Joanna Briggs Institute (JBI) Critical Appraisal Checklists for randomised controlled trials [21] and non-randomised studies (i.e., feasibility, quasi-experimental) (Fig. 1) [22]. To account for the different

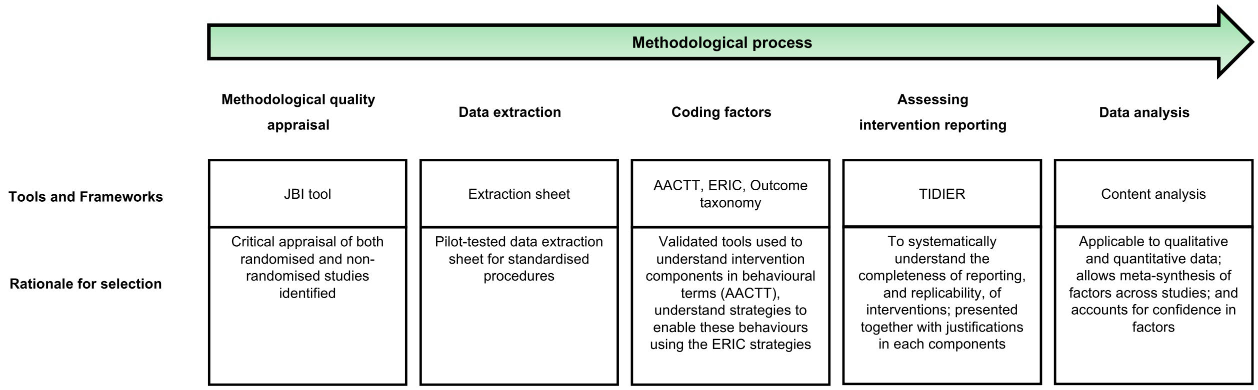

Fig. 1 Summary of tools applied in each phase of this mixed-methods scoping review

non-randomised study designs, specific checklists were used to quality assess these studies included in the scoping review. The JBI tool consists of items that were scored as: yes, no, unclear, and not applicable. The tool was not intended to generate an overall score, but we rated each study quality as high, moderate, low, or critically low based on critical domains deemed important by the Study Management Group for the different study types: (i) randomised controlled trials (items 1—3, 6—13); (ii) quasi-experimental (items 1—4, 6—9); and (iii) feasibility studies (items 1—9, 11). Owing to different types of study designs and for comparability of the overall rating, we decided to use these tools over the conventional Risk of Bias-2 tool [23] and ROBINS-I [24] tool for randomised and non-randomised studies, respectively. The use JBI tools for scoping and systematic reviews are well recognised [15]. Detailed description of scores which define quality by study type are described (appendix p 48). Three authors (SKK, SL, NDS) reviewed each study using relevant checklists depending on the study design. All studies were assessed thrice and any disagreements in ratings were discussed and resolved by consensus.

Outcome measures

The primary outcome measure was the characteristics of the hospital-initiated complex interventions for people with MLTC. The rationale for the choice of primary outcome measure was based on several rounds of consultations of the Study Management Group with expertise in the management of people with MLTC. This is because we do not know what exact interventions have been evaluated in secondary care settings and it was felt of importance to unpick them for frontline clinicians to contextualise for their clinical practice. At present, there are no formal consensus on reporting characteristics of complex interventions evaluated for people with MLTC within health systems. Therefore, we adopted a theoretical approach (Fig. 1) using behavioural and implementation frameworks to defining characteristics according to the following domains: (i) intervention groups; and (ii) strategies to implement them. To measure intervention components, we used the Action, Actor, Context, Time, and Target (AACTT) framework [25], which defines interventions delivered in behavioural terms, stakeholders involved, location of intervention delivery and recipient of these interventions. To measure strategies to implement the different intervention groups, we defined them according to the Expert Recommendations for Implementing Change framework [26] (appendix p 7—8; Table S4). The ERIC framework is a compilation of implementation strategies developed through a consensus process of implementation scientist and clinicians to improve conceptual clarity, relevance, and comprehensiveness of discrete implementation strategies. Both these frameworks are complimentary to each other and can be used to take a system-level approach to understanding these complex interventions better [27, 28].

Secondary outcomes were clinical- and cost-effectiveness, feasibility and sustainability of these complex interventions and their clinical and cost-effectiveness. Clinical outcomes are often challenging to categorise, since there is a lack of a standardised classification system. Therefore, we have applied the taxonomy for clinical outcome developed by the Core Outcome Measures in Effectiveness Trials (COMET) group [29]. The taxonomy were defined as: (i) delivery of care; (ii) resource use; (iii) functioning; (iv) clinical; (v) death according to the outcome taxonomy for clinical research. These were used to classify the primary clinical outcome measure reported in each study. Fidelity, feasibility and sustainability were defined according to the World Health Organisations implementation science evidence base [30, 31]. Briefly, feasibility was defined as the extent to which an intervention can be successfully delivered, fidelity as the extent to which an intervention gets applied as originally designed / intended and sustainability was defined as the extent to which a newly implemented treatment is maintained or institutionalised within a service setting's ongoing, stable operations.

Data extraction & analysis

A pre-designed data collection form was developed using Microsoft Excel to extract data on study-characteristics (i.e., study year, design type, and duration), patient characteristics (i.e., number of patients, type of long-term conditions), interventions and strategies to deliver them, implementation measures, clinical, and cost-effectiveness, and completeness of reporting. A template of the data collection form and the definition to each of these variables are presented (appendix p 9—10, Table S5).

Excerpts of texts relevant to characteristics and strategies to deliver these interventions were extracted from included studies. They were then grouped in preparation for narrative synthesis in a three-staged process. First, two reviewers (SKK, SL) coded and summarised each component of the interventions against the AACTT framework and implementation strategies against the ERIC framework. Both reviewers (SKK, SL) then reviewed codes, with any disagreements resolved through discussion with a third reviewer and Study Management Group as required. Secondly, we generated categories of features for key interventions, actors, timing and target of intervention, to consolidate the codes into categories. Thirdly, we grouped the components of the interventions based on these categories, using a typology developed through discussion between the Study

Management Group. The Study Management Group is a multidisciplinary team, including clinicians and methodologists. Finally, the TIDier checklist [18] was used to understand the completeness of reporting of these complex interventions. Each section of the checklist were marked as 'reported' where data were available in the full paper, and 'non reported' when no data were available on the data collection form. A summary of the methodological process applied in this scoping review is presented in appendix (p 11, Figure S1). Since the primary outcome measures were hugely variable, we did not perform any adjusted analysis taking into account the different study designs or precision of the estimates.

Ethical statement

Ethical approval was not applicable for this study, as this was a scoping review of existing literature and did not involve direct contact with human subjects.

Role of the funding source

SK was funded by the NIHR Doctoral Research Fellowship (NIHR303288). The funders had no role in study design, data collection, data analysis, data interpretation, writing of the report, or the decision to submit the paper for publication.

Results

Study characteristics

The initial search identified 14,887 records (Fig. 2). Initial screening of additional sources yielded 175 records. A second titles and abstract screening reduced the number of records to 205. Full texts were retrieved, and 135 were excluded (appendix p 12—22; Table S6). A summary of included studies from previous systematic review and reasons for exclusion are reported in appendix (p 23—27; Table S7).In total, 70 studies [32–101] were included reporting data on 56,111 patients. A summary of the studies included in the scoping review in presented in Table 1 and appendix (p 28—30; Table S8). The number of patients with polypharmacy were reported in 16 studies and the number of patients requiring > 5 healthcare professionals involved in medical care were reported in 11 studies. Reporting of polypharmacy and number of healthcare professionals involved were hugely variable and information from these studies are reported in the appendix (p 31—34; Table S9). All studies in this scoping review included patients with two or more long-term conditions, of which 42 studies provided description of these individual long-term health conditions. Most common conditions were diabetes ($n = 28$), hypertension ($n = 19$) and chronic kidney disease ($n = 14$) (appendix p 35—36; Figure S2—S3). Cardiovascular conditions

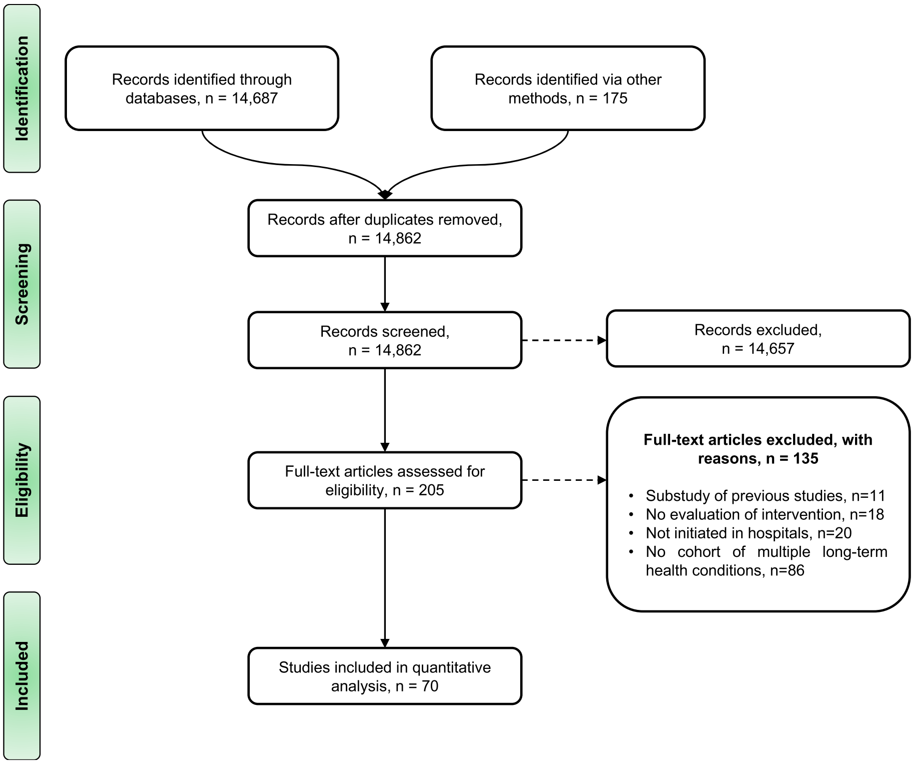

Fig. 2 PRISMA flowchart of study search and selection for inclusion into the scoping review

Table 1 Characteristics of included studies in the scoping review

		All studies, (*n* = 70 studies)
Country income	High income	62 (88.6)
	Low or middle income	7 (10.0)
	Mixed	1 (1.4)
Regions	East Asia and Pacific	15 (21.4)
	Europe and Central Asia	28 (40.6)
	Latin America and Caribbean	3 (4.3)
	North America	20 (29.0)
	South Asia	1 (1.4)
	Sub-Saharan Africa	3 (4.3)
Number of centres or country	Single centre	42 (60.0)
	Multiple centres in a single country	26 (37.1)
	Multiple countries	2 (2.9)
Study design	Non-RCT	
	Feasibility study	17 (24.3)
	Quasi-experimental	17 (24.3)
	RCT	
	Individual	29 (41.4)
	Cluster	7 (10.0)
Acuity of patient pathway	Elective	35 (50.0)
	Emergency	32 (45.7)
	Combination	3 (4.3)
Types of primary clinical outcome	Single	45 (64.3)
	Clinical	18 (27.7)
	Delivery of care	12 (18.5)
	Functioning	9 (13.8)
	Resource use	17 (26.2)
	Composite	20 (28.6)
	Clinical & Delivery of care	4 (6.2)
	Clinical & Death	1 (1.5)
	Resource use & Death	3 (4.6)
	Functioning & Delivery of care	1 (1.5)
	No outcome indicated[a]	5 (7.1)
Clinical effectiveness of models of care	Not clinically effective	10 (14.3)
	Clinically effective	43 (61.4)
	Not applicable[a]	17 (24.3)
Reporting of cost-effectiveness	No	62 (88.6)
	Yes	8 (11.4)

Abbreviations: RCT randomised controlled trial

[a] Not applicable refers to single arm feasibility study with no comparative data to report on clinical effectiveness. All seventeen studies were feasibility study

were the most common with limited inclusion of mental health and musculoskeletal.

Of the included studies, 62 (88.6%) were from high income countries and seven (10.0%) were done in low- and middle income countries. Only two studies [71, 76] was conducted across multiple countries in different settings. Twenty-eight (40.6%) studies were in Europe and Central Asia, followed by North America ($n = 20/70$, 29.0%) and East Asia and Pacific ($n = 15/70$, 21.4%). Three studies each were from Latin America and Caribbean and Sub-Saharan Africa. No studies were from North Africa and the Middle East. Seven studies were cluster-level RCTs, 29 individual-level were RCTs and 34 were non-randomised controlled trials. Most studies were conducted in one centre (*n* = 40), while 21 studies were conducted in two or more centres. Only one study was conducted in two or more countries.

Reporting and quality of studies

Of the 70 studies, 29 (41.4%) were rates overall as high quality, 33 (47.1%) as moderate, six (8.6%) as low and two (2.9%) as critically low (appendix p 38; Figure S4). For randomised controlled trials (*n* = 36), 13 studies (36.1%) scored high on method quality and 19 (52.8%) as moderate quality (appendix p 39; Figure S5). Majority of the included quasi-experimental studies (*n* = 15/17, 88.2%) were high quality (appendix p 40; Figure S6). Only one feasibility study (5.9%) was scored as high quality and majority (*n* = 12/17, 70.6%) were scored as moderate quality (appendix p 41; Figure S7). All 70 studies addressed the questions in the TIDier checklist [19] (appendix p 42—43; Table S10, Figure S8) to varying degrees. Most studies reported why they were carrying out the intervention, what the intervention was, who provided the intervention, how and where the intervention was delivered. About 51% of the included studies (*n* = 36) described the intervention intensity or dose. The least reported areas of the checklist were information about intervention fidelity (*n* = 13, 19%), modification (*n* = 5, 7%) and tailoring of interventions (*n* = 15, 21%).

Intervention components

Twelve intervention groups were identified across these studies with 52 different combinations of these intervention groups (Table 2). A summary of definitions encompassing the different intervention groups are presented in appendix (p 40; Table S11) and the different combination of interventions across the included studies are presented in appendix (pg 41—44; Table S12) The median number of intervention groups used within these studies were 2 (range: 1—6). The most common were medication review and optimisation (n = 39, 55.7%), management of chronic diseases (*n* = 34, 48.6%) and providing detailed care plan (*n* = 23, 32.9%). The most common combination of intervention groups included medication review and optimisation only (*n* = 8) and self-care management (*n* = 5) only. Majority of studies had multiple stakeholders involved in the delivery of these models of care (n = 38, 70.0%) (Table 2). Eleven studies did not specify stakeholders delivering the interventions. The most common healthcare professionals were nurses (*n* = 23, 32.8%), pharmacists (*n* = 14, 20.0%), and older people physicians (geriatricians; *n* = 10, 14.3%) (appendix p 45—46; Table S13, Figure S3). Patients were important stakeholders in 19 studies where self-care management were an intervention component. Of the 70 studies, 51 were based only in hospital, 14 studies extending into community and five into primary care.

Table 2 Characteristics of models of care from included studies by the type of intervention and implementation strategy

	All studies, (*n* = 70 studies)
Intervention groups	
Care coordination	15 (21.4)
Providing detailed care plan	23 (32.9)
Cognition assessment	12 (17.1)
Health promotion	14 (20.0)
Management of chronic disease	34 (48.6)
Medication review and optimisation	39 (55.7)
Assessment of nutrition	5 (7.1)
Referral to other specialty	10 (14.3)
Risk assessment	4 (5.7)
Screening for long-term conditions	15 (21.4)
Self-care management	19 (27.1)
Shared decision making	2 (2.9)
Number of intervention groups	
Single component	21 (30.0)
Multi-component	49 (70.0)
Number of stakeholders	
Single	21 (30.0)
Multiple	38 (54.3)
Unspecified	11 (15.7)
Setting	
Hospital only	51 (72.9)
Hospital & community	14 (20.0)
Hospital & primary care	5 (7.1)
Target	
Patient only	54 (77.1)
Patient & healthcare professional	15 (21.4)
Healthcare professional only	1 (1.4)
Implementation or delivery strategy	
Audit and feedback	8 (11.4)
Checklists	6 (8.6)
Clinical decision support system	4 (5.7)
Clinical guidelines	9 (12.9)
eHealth	5 (7.1)
Engage patients	4 (5.7)
Financial incentivisation	1 (1.4)
Integrated unit or clinic	13 (18.6)
Local champions	1 (1.4)
Multidisciplinary team meetings	10 (14.3)
Training and education	26 (37.1)

Fig. 3 Implementation strategies used reported in studies included in the scoping review (**A**) Overall strategies from the thematic analysis (**B**) Strategies according to the Expert Recommendations for Implementing Change framework across the nine domains

Implementation strategies

Strategies to implement these intervention components were reported in 50 studies (Table 2, Fig. 3A). The median number of strategies used was four (range: 1—10) and a summary of all the strategies across the ERIC domains are presented in Fig. 3B (appendix pg 47—48; Table S14). Strategies that were commonly reported across all included studies were training and educating stakeholders, use evaluative and iterative strategies (i.e., multidisciplinary team meetings, clinical guidelines, audit and feedback, checklists, eHealth, and clinical decision support system) and change infrastructure (i.e., integrated clinic or unit). One study each reported use of financial incentivisation and local champion to facilitate intervention delivery. There was variable assessment of implementation measures across the included studies. The most reported implementation outcomes were fidelity (38.7%, *n* = 24/62) and feasibility (19.4%, *n* = 12/62). No studies reported on sustainability of these interventions (appendix p 49; Figure S4).

Clinical- and cost-effectiveness

Sixty-five studies reported a primary outcome measure, of which outcomes focussed on clinical (*n* = 23), resource use (*n* = 20), and delivery of care (*n* = 17) were the most common. There were a range of outcome measures used in each of these studies (Fig. 4). A summary of outcome measures is presented in the appendix (p 54; Table S15). Given the heterogeneity in the clinical outcome measures for the different combination of intervention groups, a meta-analysis was not possible. However, the clinical estimates are presented in the appendix (p 55—67; Table S16 & S17), where available. Fifty three studies were comparative, and 43 studies reported clinical effectiveness of the intervention components evaluated. Majority of combinations of intervention groups were associated with improved clinical outcomes for patients with MLTC. Of studies using training and education (*n* = 22), only two studies reported no clinical benefit of the interventions. (appendix 68—69; Figure S11—S12). Cost-effectiveness analyses were only reported in eight (11.4%) studies, of which all demonstrated cost savings with the intervention (appendix p 70, Table S18). Estimated cost savings with interventions for patients with MLTC range from

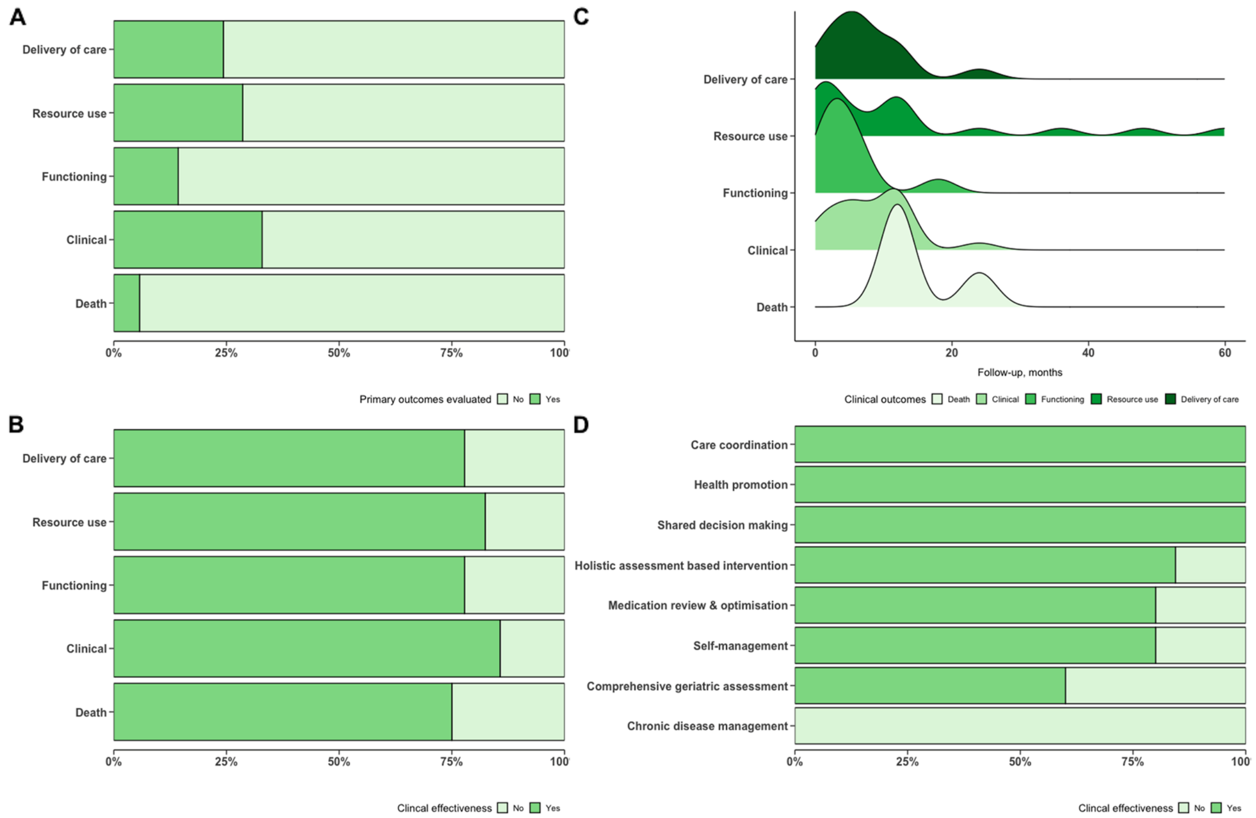

Fig. 4 Outcomes reported and clinical effectiveness of the reported models of care (**A**) Types of primary outcomes reported, according to five domains (i.e., delivery of care, resource use, functioning of daily activities, clinical and death) (**B**) Overall clinical effectiveness by outcome domains (**C**) Overall follow-up by outcome domains (**D**) Clinical effectiveness by models of care

$241 to $120,000 per year. However, cost savings are reported to be driven by shorter durations of hospital stay and fewer hospital admissions, despite additional costs from specialist clinics [56, 86]. Integrated care systems allowed improved efficiency in patient management from lower staffing needs and overhead costs [76].

Discussion

To our knowledge, this is the largest comprehensive review of hospital-initiated complex interventions evaluated for people with MLTC in secondary care. This scoping review included 70 studies across nine countries assessing the intervention components, implementation strategies and clinical effectiveness. These studies reported on twelve types of intervention components of which medication review and optimisation, management of chronic disease and providing detailed care plans were the most common. Eleven implementation strategies were reported, of which training and educating stakeholders, establishing integrated wards or clinics and regular multidisciplinary team meetings were the most common. Majority of these different combinations of complex interventions were clinically effective, especially those with training and education or integrated units or clinics. Improvement in clinical care were primarily measured through lower healthcare utilisation such as hospital readmissions or need for further management. However, closing knowledge gaps around feasibility of these complex interventions in multiple centres and its cost-effectiveness and strategies will be important to strengthen impact and scaling-up of these different models in health systems.

Key strengths of this scoping review are the robust search strategy, triple screening of identified studies, double coding of data, and robust quality appraisal. Further, we used well-validated frameworks to better understand key components of these complex interventions. However, there are important limitations to acknowledge. Firstly, the search was restricted to only reflect published, peer-reviewed literature. Therefore, this study may not capture all complex interventions for people with multimorbidity that might be in place in secondary care settings globally. Further, we utilised only English search terms and our search might have missed models published in other languages. Therefore, studies published in non-English language from low- and middle-income countries may have been missed. Secondly, data extraction and analysis were restricted to information published in articles. Although we used methods to accurately depict complex interventions based on the articles, potential inaccuracies remain a limitation of this study type. Thirdly, this review excluded studies reporting interventions or services focussed only on one condition. Although interventions or services on one long-term condition may have some relevance, evaluation of these in a cohort of people with MLTC are needed to advance our knowledge in improving care delivery across health systems. Therefore, we believe that a dedicated review focused on complex interventions for people with multimorbidity is warranted. Fourthly, the included studies have limited to no reporting of barriers and facilitators to implementation of these different combination of intervention components [102]. We recognise the importance of understanding these to improve intervention fidelity and sustainability. Finally, we did not perform evidence synthesis of clinical-effectiveness using meta-analysis techniques or adjusted analysis taking into account the study designs. This is because there is limited number of studies of a particular combination of interventions and primary outcome measures used. However, we have descriptively presented whether each combination of interventions reported a clinical benefit.

This scoping review helps to address the evidence gap on the current interventions delivered in secondary care for adults with MLTC, under the UK NICE Multimorbidity Guideline [103]. At present, different interventions have been identified to be clinically effective in reducing hospital admissions and improving management of chronic disease. For example, the comprehensive geriatric assessment is used in both elective and emergency settings for older adult patients' with MLTC [54, 104, 105]. Similarly, several studies examined the use of an integrated clinic or ward with a multidisciplinary team to optimise chronic diseases. However, the heterogeneity of these different complex interventions means no simple solution exists for any health and social care system to implement. However, the growing political and clinical interest in developing integrated care systems for people with MLTC, including in secondary care requires context-specific strategies to implement intervention components. Further, integrating care into the community or primary healthcare will allow a coordinated approach to improve long-term health of patients. In secondary care, implementation of these different intervention components or models are challenging due to several reason. First, there is already an existing high workload by different healthcare professionals, limiting opportunities to do more. Therefore, training and education of healthcare professionals may be helpful. This is particularly important to support clinicians with shared decision making around management of MLTC [106]. Second, financial systems to fund these are challenging to justify in the lack of impact budget models or cost-effectiveness in place. Finally, the lack of integration of digital care systems or computer systems, makes communication of clinical information between primary and secondary care systems challenging [107].

This study identifies several areas for future research. First, a theoretical approach to intervention design is needed to better uncover the "black box" of complex interventions [108]. Although this study have attempted to identify core components within these complex interventions using behavioural and implementations frameworks, reporting of intervention delivery and fidelity are hugely variable. These limits understanding of the combination of components within the complex interventions that are effective in different contexts [18] to support wider scale-up. Second, evaluation of these complex interventions is limited by the lack of implementation-based research. This is especially important in the context of multi-component interventions involving multiple healthcare professionals. Therefore, there is a growing need for designing hybrid implementation-effectiveness trials [109] which allows structured evaluation of implementation strategies. Learning during the process evaluation will minimise implementation gap, if the model of care demonstrates good clinical- and cost-effectiveness. Thirdly, there is little to none process evaluation to understand impact of these complex interventions on measures such as deprescribing behaviours or perceived improvements in coordination of care. This means there is little understanding on the barriers and facilitators to implementing these interventions. Therefore, future research should have greater emphasises to design comprehensive studies evaluating these measures in a whole-systems approach, to take into account intended and unintended consequences [110, 111]. Better understanding processes to address multimorbidity in these patients will service to strengthen health systems and a means to achieve universal health coverage [6].

Hospital-initiated complex interventions encompassing multiple stakeholders appear to be feasible and clinically effective for people with MLTC. These complex interventions appear to have benefit in reducing hospital admissions and improving health-related quality of life. However, to strengthen impact and support wider scale-up across health systems, closing knowledge gaps around cost-effectiveness and strategies to improve implementation of these complex interventions will be crucial.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12913-025-12424-2.

Supplementary Material 1.

Acknowledgements
None declared.

Authors' contributions
SKK, KN, JD, SA, AB, and DG conceptualised the systematic review and developed the search strategy. SKK, SL and NDS performed the screening of the studies, data extraction, thematic analysis and quality appraisal. JG and DN were involved in quality assuring the thematic analysis to ensure appropriate use of the framework. SKK, KN, JD, SA, AB, and DG, developed the first draft of the manuscript. SKK, SL, NDS, JCG, DN, SB, JY, TP, KN, JD, SA, AB, and DGM contributed to the review and editing of the final manuscript.

Funding
SK was funded by the NIHR Doctoral Research Fellowship (NIHR303288). The views expressed are those of the authors and not necessarily those of the NIHR or the Department of Health and Social Care.

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Ethical approval was not applicable for this study, as this was a scoping review of existing literature and did not involve direct contact with human subjects.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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Received: 31 December 2024 Accepted: 12 February 2025

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