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Measuring care coordination for people with multiple long-term conditions using electronic health records: a scoping review

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Systematic Review

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Measuring care coordination for people with multiple long-term conditions using electronic health records: a scoping review

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Abstract

Care coordination is essential to high-quality care for people living with multiple long-term conditions (MLTC), yet no standardised measure of coordination derivable from electronic health records (EHRs) exists for assessing care quality. This scoping review identified and mapped measures of care coordination and relational continuity applicable to routinely collected electronic health data and assessed their relevance to people living with MLTC. Following Joanna Briggs Institute methodology, we searched MEDLINE, EMBASE, CINAHL, PsycINFO and Scopus to February 2025, supplemented by grey literature searching and citation chasing. Titles and abstracts were dual-screened, and records applying existing measures were keyword-triaged for derivability from routinely collected data. Eligible measures were charted and mapped to the domains of the Agency for Healthcare Research and Quality Care Coordination Atlas and to relational continuity, with each mapping classified as direct or indirect. Searches identified 7,074 records; 38 studies met the inclusion criteria, contributing 64 unique measures. Studies were

predominantly US-based and used claims or population-level data; only two focused specifically on people with MLTC. Measures clustered around accountability, monitoring and follow-up, and relational continuity. No measure captured proactive care planning or linkage with community resources, and only two addressed support for self-management. Of 137 measure-to-domain mappings, 93 (68%) were indirect, inferring coordination from patterns of contact. Routine electronic data record the observable traces of coordination more readily than its anticipatory, relational and person-centred aspects. Population-level evaluation is likely to require a small suite of complementary routine-data indicators, interpreted alongside patient-reported measures; no single indicator will suffice.

Keywords: care coordination; multiple long-term conditions; multimorbidity; electronic health records; continuity of care; scoping review

Measuring care coordination for people with multiple long-term conditions using electronic health records: a scoping review

Introduction

Care coordination, the deliberate organisation of care activities involving multiple professionals, services, and agencies, is widely considered central to improving health outcomes, patient experience, and the sustainability of health and care systems.[1–5]

Effective care coordination is particularly pertinent for people living with multiple long-term conditions (MLTC), many of whom receive care from numerous providers across primary, secondary, community, and social care, with different conditions managed

in parallel, through separate pathways. MLTC are increasing internationally, with rising prevalence in ageing populations and earlier onset in more deprived groups[6] and are consequently a central focus of research and policy agendas.[7,8] Current pathways often fail to account for MLTC, leaving people to navigate multiple appointments, care transitions and siloed plans, with potentially conflicting messages, especially for those with discordant MLTCs (where conditions have conflicting management requirements), thereby increasing the likelihood of suboptimal care.[9–11] Reviews of integrated care and of care coordination for multimorbidity have catalogued models and elements of care but found that few address the complexity of multimorbidity explicitly.[12,13] People with MLTC and their informal carers often experience a substantial 'treatment burden' in addition to 'illness burden' from the conditions themselves, and iatrogenic burden from polypharmacy and increased risks of falls and cognitive impairment.[4,14,15]

Recent umbrella-reviews suggest that coordination-centred holistic assessment and management models can improve aspects of coordination and may improve outcomes for older people with MLTC and frailty.[16–18] Health and social care costs rise sharply with the number of long-term conditions, particularly in deprived populations.[19–21] Measuring and improving coordination for people with MLTC may therefore be central to care system sustainability.[19–21]

Coordination is conceptualised as multidimensional. From a healthcare-system perspective, the Agency for Healthcare Research and Quality Care Coordination Measures Atlas (AHRQ;[1]) distinguishes a set of coordination activities, spanning accountability, communication and information transfer, transitions of care, care planning, and monitoring and follow-up, from the broader approaches through which

coordination is delivered, such as teamwork, health IT and the health care home.[1,4,22] The full domain set is reported in Table 1.

These domains intersect with relational continuity, which describes sustained patient–clinician relationships over time and is theorised to support coherent care.[23,24] Patient and family carer perspectives on coordination, while diverse, often emphasise the value of feeling known by clinicians, of being supported across transitions, and of not being left alone to manage complexity.[25–27]

Internationally, care coordination measures use varied formats, including patient- and provider-reported data and indicators derived from administrative and EHR sources.[1,2,28] There is no consensus on a comprehensive measure suited to adults with MLTC that is feasible across settings and compatible with routinely collected data, particularly across systems spanning health and social care.[29–31] There is a need for tools that enable large-scale, standardised evaluation of MLTC pathways[8,32] and routinely collected data provides an increasingly important basis for such evaluation at population scale and over time.[33,34] Previous reviews have catalogued coordination measures irrespective of the data required to compute them, leaving unclear which are derivable from records already collected in routine care.

Transformative national policies focused on MLTC, such as England's Neighbourhood Health Framework.[35] It aims to create mechanisms to support person-centred, proactive, digitally enabled, and integrated services for people with MLTC across health, social care, public health, wellbeing, welfare, and the Voluntary, Community, Faith and Social Enterprise (VCFSE) sector. These services are intended to be delivered closer to home,

with a strong emphasis on prevention and continuity of care. However, the lack of validated measures of care coordination remains a key barrier to effectively monitoring and evaluating policy implementation and its related commissioned services.

Given such policy imperative to improve coordinated MLTC care and the growing reliance on routine data for monitoring and evaluation, systematically mapping and appraising routine-data compatible measures is timely and necessary.[8,11,32–34,36–39] This scoping review aims to identify and examine measures of care coordination and relational continuity that can be derived from routinely collected data, map them to established coordination domains, and examine their suitability for evaluating care for people living with MLTC.

Methods

Design

To identify, describe, and map the breadth and characteristics of existing measures, we conducted a scoping review in accordance with the Joanna Briggs Institute (JBI) methodology.[40] Methods were pre-specified within the project's working group, a multidisciplinary body of MLTC experts including those with lived experience.[41]

Inclusion criteria

Inclusion criteria were defined using the JBI Population–Concept–Context (PCC) framework.[40]

Population

We included studies involving care coordination for adults living with MLTC, defined as the presence of two or more long-term physical, mental health, or cognitive conditions.[18] Because studies focusing exclusively on MLTC are limited, studies focused on a single condition and the general adult population were also included if the measures they reported were applicable to coordination of care across multiple providers, settings, or transitions, and could in principle be applied to MLTC populations. Studies focusing exclusively on neonatal, paediatric, obstetric, midwifery, or conditions-of-birth populations were excluded.

Concept

We used the AHRQ Care Coordination Atlas[1] as the conceptual framework for care coordination, mapping included measures to its domains and sub-domains. We additionally included the concept of relational continuity, drawing on Haggerty's framework of continuity of care, which distinguishes informational, management, and relational continuity.[23] Relational continuity was added on two grounds: it was identified by our patient and public involvement and engagement (PPIE) group as critical to care coordination for people with MLTC, and it was not adequately captured by the Atlas. In contrast, the other two Haggerty domains (informational and management continuity) were judged to overlap substantially with existing Atlas domains and were therefore not included.

Within this conceptual scope, we included instruments, frameworks, and tools designed to measure these constructs. Eligible measures included patient-reported outcome or experience measures, professional-reported or organisational measures, structured

observation or record-based tools, algorithmic or network-based measures derived from routinely collected data, and conceptual frameworks explicitly linked to measurement. The findings of this review informed a subsequent stakeholder consultation to prioritise candidate routine-data measures for people living with MLTC, reported separately.[26]

We excluded studies whose measures did not address coordination across multiple providers, settings, or transitions (e.g. measures limited to single-specialty units, within-department handovers, or organisational integration without a patient-level coordination component).

Context

Studies conducted in any health or social care setting were eligible, including primary, secondary, community, and residential or nursing care, and from any country or health system. No restrictions were placed on publication date or language, subject to feasibility of translation.

Types of sources of evidence

We included quantitative, qualitative, and mixed-methods studies reporting the development, validation, evaluation, or application of care coordination measures; methodological or conceptual papers presenting measurement frameworks; and relevant grey literature. Conference abstracts, dissertations and opinion pieces were excluded. The references of systematic reviews of existing measures were checked to identify potentially relevant primary studies or measures.

Search strategy

A three-step search strategy was implemented[40] with an information specialist. Searches were conducted in MEDLINE, EMBASE and PsycINFO (all via OVID), CINAHL (EBSCO), and Scopus. These were supplemented by targeted grey literature searches, citation chasing of included studies and key reviews, and consultation with the wider team. Search terms combined keywords and controlled vocabulary relating to care coordination, continuity of care, integration and measurement instruments (see Supplemental Material 2).

Grey literature searches comprised two complementary strands. First, Google Advanced Search was used with the term "care coordination measure", with academic-publisher domains excluded to focus results on non-peer-reviewed sources; searches were conducted in private browsing mode with cookies disabled, and the first five pages of results were reviewed (stopping early where results were repetitive or of low relevance). Second, targeted searches of relevant organisational websites were conducted using both Google site search and internal search functions; organisations included NICE, AHRQ, The King's Fund, Nuffield Health, Social Care Institute for Excellence, Gov.uk, Joseph Rowntree Foundation, and the WHO Library. Relevant website URLs are provided in Supplemental Material 2. The selection of organisations reflected those most likely to publish measurement evidence relevant to MLTC care coordination, including UK, US, and international bodies. Records were screened for measurement tools relevant to care coordination. Documents describing care coordinator roles, or describing care coordination generally without measurement content, were excluded. Records that could not be translated were excluded at full-text stage, with reason documented. The final searches were run on 18th February 2025**.** Full database search syntax, the grey literature

search protocol (including specific organisational websites and excluded academic-publisher domains), and supporting documentation are provided in Supplemental Material 2.

Study selection

Search results were de-duplicated in EndNote and uploaded to Rayyan©.[42] Titles and abstracts, and then full texts, were screened independently in pairs by members of the project team (VD, NS, AT, KW, PB, FD), with each record reviewed by two independent reviewers. Records were ordered alphabetically by first author and allocated to reviewers in proportion to their available project time. Disagreements were resolved through discussion, with arbitration by a third reviewer from the team where required.

To prioritise studies most likely to report relevant measures, records were categorised into six predefined 'levels' based on their primary measurement focus: (1) development of a care coordination measure; (2) application of an existing care coordination measure (or components) in research; (3) development of a relational continuity-of-care measure; (4) cultural or linguistic adaptation of a measure; (5) conceptual or practice-oriented studies related to care coordination; and (6) application or review of existing continuity-of-care measures.

Levels 1–3 were prioritised for full-text screening as most likely to contain eligible measures. Levels 4–6 were used as a sense check: records in these categories were reviewed to ensure no eligible measure was missed but were not the primary source of included measures. Given the volume of Level 2 records, a keyword-based triage was applied in Endnote© at full-text stage to identify measures derivable from routinely

collected data sources (e.g. EHR, administrative data, claims data, care plans, or electronic care records); the keyword list is provided in Supplemental Material 2. Measures not derivable from routinely collected electronic data alone were excluded, including those requiring additional primary data collection (e.g. survey or interview data) to be computed.

Data extraction

A structured data extraction (charting) form was developed, piloted, and iteratively refined.[43] Data extracted included study characteristics (author, year of publication, country, setting, study design) and population characteristics (including definitions of MLTC). Detailed information was extracted for each measure, including its name and description, type and perspective of measurement, target population and level of application, data source, respondent or source of information, mode of completion, recall period, and response options. Where studies included more than one measure, each was extracted and recorded separately. Extracted concepts covered coordination and continuity domains, theoretical basis, and intended measure purpose.

We extracted the data source used to derive each measure (e.g., EHR or administrative/claims datasets) and its development perspective (patient, clinician, system/administrative, or mixed), based on whether it was patient-reported, clinician-reported, derived from routine data without survey input, or combined multiple perspectives. Where available, psychometric (e.g., reliability, validity) and practical (e.g., length, licensing) characteristics were also recorded.

Reviewers piloted the extraction tool to ensure consistency. Once agreement was reached, single extraction with verification was used for the remaining studies. Consistent with scoping review methodology,[43] data extraction was descriptive without appraisal or prioritisation of measures. Taken together, eligibility was therefore determined across four sequential stages, with studies or measures able to be excluded at each: keyword triage of Level 2 records, at which measures not derivable from routinely collected data were excluded; full-text screening against the inclusion criteria; charting, at which the same criterion was applied to records at Levels 1 and 3, and measures duplicating one already charted were excluded; and domain mapping, at which records not describing a distinct measure that could be mapped to a coordination or continuity domain were excluded. The numbers excluded at each stage are shown in the PRISMA-ScR flow diagram (Figure 1).

Attribution and measure identity

Two rules governed how measures were counted. First, a measure was attributed to the earliest source included in the review in which it was used as a measure of care coordination or continuity of care, rather than to the earliest statistical or methodological origin. Where an earlier originating source was identified but could not be obtained, or was ineligible under the inclusion criteria, the measure was attributed to the earliest eligible included source. Origins that could not be retrieved into the review are not cited, and lineage beyond the included set was not traced.

Second, where a study reported the same measure under more than one specified parameter value, for example follow-up windows of both 7 and 30 days, each specified

version was recorded as a separate measure, since the value affects what the measure detects. Where the measure's definition did not fix such a value, it was recorded once and the variation noted. Versions differing in a specified value were not merged at synthesis, and are reported separately in Table 4 and Supplemental Material 4.

Data analysis and synthesis

Included measures were summarised descriptively by study and measure characteristics (Table 2) and mapped to the AHRQ Care Coordination Atlas domains[1] and the additional relational continuity domain.[23] Each measure-to-domain mapping was further classified as direct or indirect. A mapping was classified as direct where the measure explicitly records a coordination action or event relevant to that domain, and as indirect where the measure infers the construct from patterns of service use or from the presence of supporting infrastructure. On this basis, continuity and concentration indices, and measures of health-IT capability, were classified as indirect. To avoid overstating the breadth of individual measures, a measure was mapped to a domain only where the mapping reflected what the measure was designed to capture, rather than every domain the measure could be argued to touch. Where a broad measure could be related to many domains, but the additional mappings added little to understanding its purpose, those mappings were not made, and the measure was mapped to the domains it most directly and meaningfully addressed. This restraint was applied consistently across measures, and means the domain counts reflect measures' primary coordination content rather than their maximum conceptual reach.

Narrative synthesis was used to integrate findings across included measures, following the framework of Popay et al.[44] The synthesis combined descriptive summary of study and measures of AHRQ Care Coordination Atlas domains,[1] and the additional relational continuity domain;[23] see Tables 3 and 4), and narrative integration of findings across measures by domain. Particular attention was given to priorities for MLTC care coordination identified through the project's PPIE and stakeholder consultation work ,[26] including teamwork and communication across sectors, continuity and smooth transitions, and patient-centredness, and to equity considerations relevant to MLTC populations. Mapping was based on review of measure descriptions and item content, using predefined criteria (Table 1) rather than author labels. Because most measures were not originally developed with the AHRQ Atlas domains in mind, mapping required reviewer judgement; disagreements were resolved through discussion.

Table 1: Care coordination and relational continuity domains, concepts and criteria for measure fit

Mapping domain and concept	**Criteria for measure fit** *(A measure aligns with a domain if it captures one or more of the following*
ATLAS Activities[1]	
Accountability Establish Accountability / Negotiate Responsibility (Clarity about who is responsible for which aspects of care/coordination, and that they are answerable for failures)	The measure assesses whether **a specific person, team, or organisation is i** **responsible** for coordinating some part of the patient's care. The measure assesses the **clarity of roles and responsibilities** between diff (e.g. who does what, when). The measure captures whether **patients and/or providers know who is "in** care or coordination. The measure includes whether the responsible entity is **expected to answer** aspect(s) of care they are accountable for (implicit or explicit "answerability The measure captures **transfer or handover of responsibility** (e.g. when re one provider/service to another and whether that handover is clear).
Communication *Interpersonal Communication* (Two-way exchange of ideas,	The measure assesses **two-way communication** between patients and provi (e.g. opportunity to ask questions, discuss goals, clarify plans). The measure assesses **sharing of preferences, goals, or experiences** (not ju

preferences, goals, experiences through personal interaction)	coordination. The measure covers **quality of interaction** (e.g. listening, understanding, re making) rather than just whether contact occurred. The measure refers to **personal interaction channels** (e.g. face-to-face, pho with back-and-forth, patient portals with messaging).
Information Transfer (Transfer of clinical data/information about the patient (may be one-way, any medium)	The measure captures **transmission of clinical information** (e.g. summarie lists, discharge letters, care plans) between participants in care. The measure specifies **sender and receiver** of information (e.g. hospital → clinician). The measure assesses **timeliness and completeness** of information transfer. The measure includes **medium of transfer** (e.g. EMR, letters, electronic me least implies a mechanism. The measure distinguishes between **having information available vs. not a** care.
Facilitate transitions	The measure assesses **transitions between different care settings** (e.g. inp
Transitions of care across settings (Supporting safe, coordinated transfer of information and responsibility **between care settings)**	primary care → specialist; hospital → community care). The measure captures **transfer of clinical information** during transitions (e referral letters, handover documentation). The measure assesses **transfer or sharing of accountability/responsibility** receiving services. The measure includes whether transitions are **timely** (e.g. within a specified The measure includes whether information is **complete and usable** by the r The measure captures whether information or responsibility **successfully re setting**.
Transitions of care as coordination needs change over time (Supporting continuity and coordination across changing needs, stages, or phases of care over time)	The measure assesses **transitions between phases of care** (e.g. acute episo management). The measure captures **life-course transitions** (e.g. paediatric → adult care; changes). The measure reflects **adaptation of responsibility or care plans over time** The measure assesses whether **coordination is maintained longitudinally** The measure includes whether patients experience **continuity during trans** single handover points.
Care Planning	The measure assesses whether there is a **structured assessment of patient**
Assess needs and goals (Systematic assessment of patient needs (physical, emotional, psychological, functional, social), health history, self-management, treatments, and support needs)	psychological, functional). The measure includes **current health status and health history**, including relevant. The measure assesses **current treatment recommendations** (including me are reviewed together. The measure considers **self-management capacity** and behaviours (e.g. kn The measure includes **needs for support services** (e.g. social care, financia caregiver support). The measure captures whether **goals are elicited from the patient/family**,
Create a Proactive Plan of Care (Ongoing, shared care plan that anticipates needs, identifies gaps, and sets goals.)	The measure explicitly references a **care plan, treatment plan, or coordina** The measure assesses whether the plan is **jointly created and/or reviewed** care team. The measure captures whether the plan **addresses identified gaps in coordi** unclear responsibilities, unmet needs). The measure includes **patient goals** (and sometimes provider/service goals) them.

	The measure reflects whether the plan **anticipates routine and future need** crises.
	The measure includes **updating or revising the plan** as circumstances chan
Monitor Follow-up and Respond to Change (Ongoing tracking of progress, detecting problems, and adjusting care/plan.)	The measure captures **follow-up actions after care events** (e.g. after discha medication, after tests).
	The measure assesses whether **patients' progress toward goals** is monitore
	The measure includes **monitoring for failures, adverse events, or gaps in** picked up.
	The measure captures **responsive action when changes or problems are d** referrals, medication changes).
	The measure may cover **planned review schedules** (e.g. regular check-ins,
Patient Centredness	The measure assesses provision of **education, coaching, or training** to sup
Support self-management goals (Tailored education/support so patients (and informal carers) can participate in and navigate their care)	The measure captures whether support is **tailored to the patient's capacity circumstances**.
	The measure includes support for **navigating care pathways and transitio** who to contact, what to expect).
	The measure captures **self-efficacy or confidence** in managing health and a
	The measure recognises and/or involves **informal caregivers** in self-manag relevant).
Link to Community Resources (Connection to non-health-care community resources that support health and care goals)	The measure assesses whether **information about community resources** (e support groups, programmes) is provided.
	The measure captures actual **coordination or referral to community servi**
	The measure includes a **range of community resources** (e.g. financial, soci support) beyond purely clinical services.
	The measure connects these resources to **patient-defined goals or needs** (e participation, housing, food security).
	The measure recognises coordination between **health and non-health secto** voluntary sector).
ATLAS Approaches[1]	
Teamwork (Integration of multiple entities into a cohesive team that can meet patient needs)	The measure captures **collaboration between different professionals, tean** a patient's care.
	The measure assesses whether the team has **shared goals, shared care plan understanding** of roles.
	The measure reflects **coordination processes within the team** (e.g. regular conferences, joint decision-making).
	The measure includes **mutual awareness of each other's work** and inter-d location).
	The measure captures whether teamwork leads to **coherent, 'joined-up' ca** perspective.
Care management (Structured processes to help patients and supports manage conditions efficiently and effectively)	The measure captures **systematic assessment, planning, facilitation, and c** or groups.
	The measure assesses involvement of a **care manager / case manager / coo**
	The measure reflects **use of available resources to meet patient needs** effi
	The measure includes **advocacy or problem-solving** on behalf of patients.
Medication management (Reconciling and coordinating medication use to avoid errors and adverse events, especially at transitions)	The measure captures **medication reconciliation** across settings or provide resolving discrepancies).
	The measure includes assessment of **polypharmacy, potentially inappropr** drug interactions as part of coordination.
	The measure captures whether **complete and accurate medication informa** shared across providers.

	The measure addresses **problems or adverse events related to medication** admission, discharge, transfer between services). The measure includes **communication with patients** about their medicines lists).
Health IT-enabled coordination (Use of digital tools to facilitate coordination and maintain information over time)	The measure explicitly involves **electronic health records, shared care rec IT systems** as coordination tools. The measure captures how IT supports **information transfer** (e.g. e-referra sharing). The measure includes **patient-facing IT** where relevant (e.g. portals, apps) and communication. The measure assesses **extent and quality of IT use** for coordination (e.g. co interoperability). The measure reflects whether IT supports **longitudinal information contin** over time).
Health care home (medical home / patient-centred medical home) (A usual source of care that acts as the central hub for coordination)	The measure assesses whether patients have a **usual source of care / usual practice**. The measure captures whether the home **coordinates across multiple provi** the patient. The measure reflects **comprehensiveness** (range of services) and **accessibil** The measure assesses how **patient-centred** the home is (e.g. respect for pre continuity). The measure includes coordination with **non-clinical services** where releva community support).
Relational Continuity[23] (An ongoing, therapeutic relationship between a patient and one or more providers/team over time, characterised by familiarity, trust, and a sense that someone "knows me" and takes responsibility)	The measure assesses **seeing the same provider/team over time** (e.g. usua visits with same clinician, duration of relationship). The measure captures **patient perception of being known as a person** (not provider/team. The measure includes elements of **trust, confidence, or sense of security** in The measure reflects **accumulated knowledge** about the patient's history, p the use of that knowledge in care. The measure captures whether patients feel the provider/team **takes ongoing** overall care (not just isolated episodes). The measure may include **ease of contacting the same provider/team** whe

For a subset of measures identified through Level 2 records (application of an existing care coordination measure in research), initial mapping to AHRQ Care Coordination Atlas domains was supported by a custom-prompted use of ChatGPT (OpenAI; GPT-5, and GPT-5.1 following its release in November 2025), accessed between September and November 2025. The AI was prompted to suggest domain assignments and to extract text excerpts from the original measure descriptions supporting each assignment, against the predefined criteria in Table 1. All AI-generated suggestions were reviewed and verified independently by two members of the research team (VD, AT), with disagreements with

the AI output and between reviewers resolved through discussion. Final mapping decisions were made through reviewer consensus following independent verification. The full prompt, a worked example of the AI-generated output, and further details of the reviewer verification workflow are provided in Supplemental Material 3 to support transparency and reproducibility.

Patient and public involvement and engagement

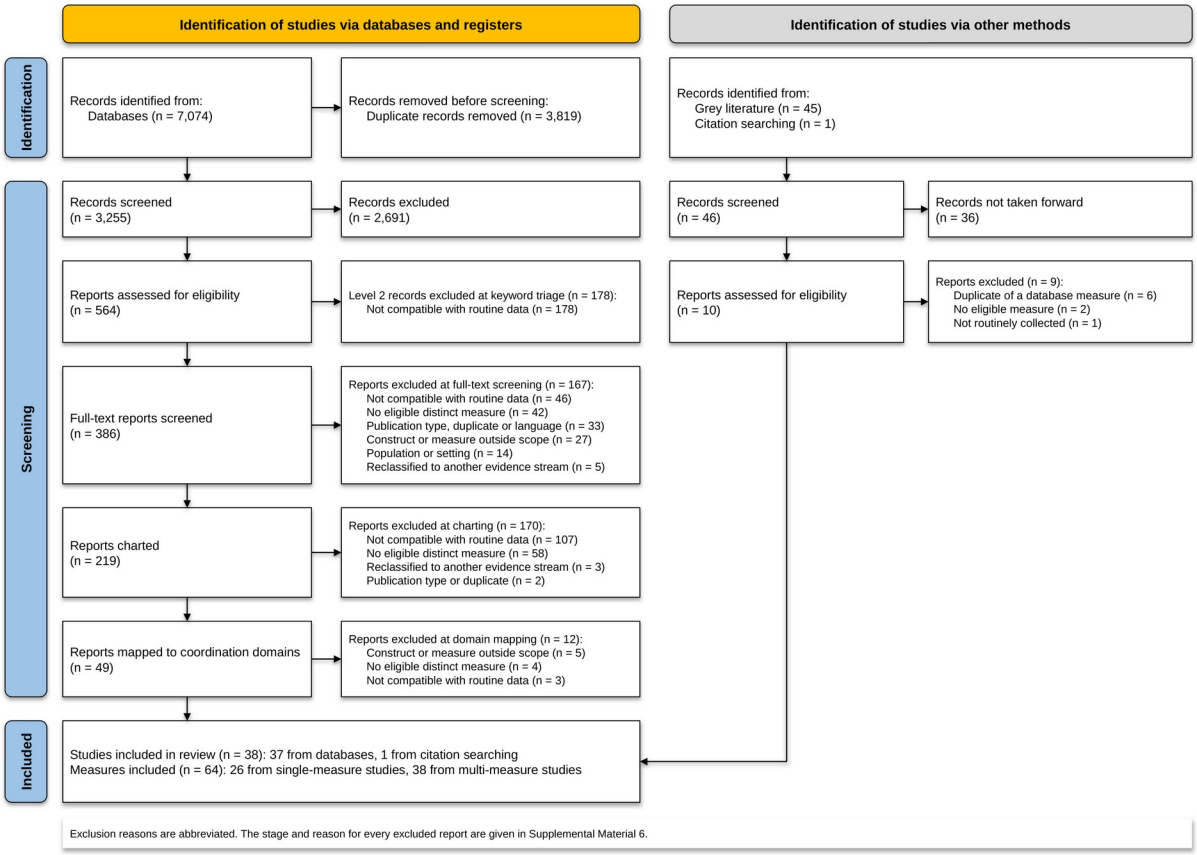
People living with MLTC and informal carers, alongside a broader stakeholder consultation including professional stakeholders, MLTC researchers and data experts, contributed to identifying care coordination as a research priority, shaping the review questions, and refining the focus on feasibility and inequalities, in line with recommended roles for knowledge users in scoping reviews.[43] Detailed methods and findings from the stakeholder consultation, including a prioritisation of candidate measures, are reported separately.[26] PPIE contributors supported interpretation of findings and development of accessible summaries. PPIE activity was documented and reported in line with UK Standards for Public Involvement.[45]

Results

The study selection process is summarised in Figure 1, with the report-level audit trail in Supplemental Material 6.

Figure 1. Study selection flow diagram (PRISMA-ScR). Records were identified from five bibliographic databases and from grey literature and citation searching; the four eligibility stages (keyword triage, full-text screening, charting and domain mapping) are

shown with reasons for exclusion at each. The report-level audit trail is provided in Supplemental Material 6.



Searches identified 7,074 records; 38 studies met inclusion criteria, contributing 64 unique measures. Study and measure characteristics are reported in **Table 2**; further study-level details are provided in **Table 3**.

Characteristics of included studies and their measures

Included studies

Studies were conducted predominantly in the United States, and half used claims-based or population-level data spanning multiple settings (see Table 2). Only two studies focused specifically on people with MLTC populations.

Identified measures

Across the 64 measures identified, the dominant developer perspective was system or administrative (**Table 2**; 84%), reflecting the predominance of EHR- and claims-derived tools. Patient-perspective measures comprised a small minority (6%), with mixed patient-and-system measures (6%) and clinician-only measures (3%) less common again. Validation was concentrated among the continuity indices and the structured indicator sets, and was absent for most network-based and composite measures.

Table 2: Characteristics of included studies (n =38) and their measures (n =64)

Characteristics	**N (%)**
Country / region (n = 38 studies)	
North America	28 (73.7%)
Europe	6 (15.8%)
Asia	3 (7.9%)
Oceania	1 (2.6%)
Setting (n = 38 studies)	
Claims or population-level data spanning multiple settings	19 (50.0%)
Primary care	10 (26.3%)
Ambulatory / outpatient care	3 (7.9%)
Integrated health system	3 (7.9%)
Hospital	2 (5.3%)
Methodological (no care setting)	1 (2.6%)
Population (n = 38 studies)	
General adult population	27 (71.1%)
Single disease	9 (23.7%)
MLTC	2 (5.3%)
Study type (n = 38 studies)	
Observational – retrospective cohort (claims / EHR / registry)	19 (50.0%)
Observational – cross-sectional (survey / single time point)	6 (15.8%)
Observational – methodological / measurement study	10 (26.3%)
Observational – network analysis	1 (2.6%)

Interventional/ quasi-experimental	2 (5.3%)
Perspective of measures (n = 64 measures)*	
System/ administrative	54 (84.4%)
Patient	4 (6.3%)
Mixed (patient and system)	4 (6.3%)
Clinician	2 (3.1%)

Note: [+]Categories were not mutually exclusive; percentages are based on included studies. *Perspective of measure: from which perspective the measure was developed. "Mixed" refers to measures combining patient and system perspectives; no measures combined clinician with patient or system.

Table 3: Overview of included studies (n=38)

Title of publication	First author	Year	Journal	Country of origin	Population	Setting
Development and testing of indicators to measure coordination of clinical information and management across levels of care	Aller[46]	2015	Int J Integr Care	Spain	General population	Patients v diabetes, COPD, o lung, blad cancer, re levels of coordinat primary a secondary Catalan p healthcar
Patient medical group continuity and healthcare utilization	Anderson[47]	2012	Am J Manag Care	US	General population	U.S. insu a Minnes plan; prin continuity claims da 2009)
ACO Affiliated Hospitals Increase Implementation of Care Coordination Strategies	Anderson[48]	2019	Medical Care	US	General population	U.S. com hospitals American Associati data
Improving clinical	Balasubramania	201	J Gen Intern Med	US	General	Mayo Pri

access and continuity through physician panel redesign	n[49]	0			population	Internal M Primary c practice c physician
Evaluating continuity and comprehensiveness of care in an elective family practice clerkship	Beasley[50]	1985	Acad. Med.	US	General population	Students members family me UWM Sc
Population-based Cancer Screening Measurement of Coordination and Continuity of Care	Benito[51]	2018	Cancer Nursing	Spain	General population	Populatio breast and cancer sc programm
Measures of care coordination at inpatient psychiatric facilities and the Medicare 30-day all-cause readmission rate	Benjenk[52]	2020	Psychiatric Services	US	Single disease	Inpatient facilities; FFS admi
A quantitative measure of continuity of care	Bice[53]	1977	Med Care	US	General population	Patients v healthcar
Patient sharing among physicians and costs of care	Pollack[54]	2013	J Gen Intern Med	US	Single disease (CHF, diabetes)	Claims-b (Medicar l), multi-p
Using an integrated COC index and multilevel measurements to verify the care outcome of patients with multiple chronic conditions	Chan[55]	2012	BMC Health Serv. Res.	Taiwan	MLTC	Primary c (ambulato national h insurance
Longitudinal care continuity and avoidable hospitalization: the	Cheng[56]	2023	BMC Health Serv. Res.	Taiwan	General population	Ambulato care setti TNHI cla

application of claims-based measures						
A fundamental metric for continuity of care: Modeling and performance evaluation	Citro[57]	1997	IEEE Trans. Inf. Technol. Biomed.	US	General population	Patients i represent model HM Arizona (HealthCa
The association between care co-ordination and emergency department use in older managed care enrollees	Coleman[58]	2002	International journal of integrated care	US	MLTC	Enrollees months o claims da
Physician-Level Continuity of Care and Patient Outcomes in All-Payer Claims Database	Dai[59]	2024	JABFM	US	General population	Primary c data from Database APCD).
Effects of health information technology and health information exchanges on readmissions and length of stay	Daniel[60]	2018	Health Policy Technol.	US	General population	Hospitals Medicare HIMSS a survey da
Assessment of patient/doctor continuity in primary medical care	Ejlertsson[61]	1980	Occasional Paper 10, Journal of the Royal College of General Practitioners	Sweden	General adult population	Primary c (Swedish centre)
Quantitative measurement of continuity of care: Measures in use and an alternative approach	Eriksson[62]	1983	Med Care	Sweden	General population	Patient vi Swedish health ca
Measuring continuity of care for clients of public mental health systems	Fortney[63]	2003	Health Serv. Res.	US	Single disease	Houston, administr from two mental he systems; serious m sampled f shelters, s public me clinics

Factors Associated With Resident Continuity in Ambulatory Training Practices	Fortuna[64]	2016	J. Grad. Med. Educ.	US	General population	Four amb residency training p (internal m pediatrics family m medicine-
Interpersonal Primary Care Continuity for Chronic Conditions Is Associated with Fewer Hospitalizations and Emergency Department Visits among Medicaid Enrollees	Gaglioti[65]	2023	JABFM	US	General population	Populatio Medicaid (ages 18– United St from 26 s 2009 Mec
The next step towards making use meaningful: electronic information exchange and care coordination across clinicians and delivery sites	Graetz[66]	2014	Medical care	US	Clinician	KPNC in delivery s primary c clinicians
A time-duration measure of continuity of care to optimise utilisation of primary health care: A threshold effects approach among people with diabetes	Ha[67]	2019	BMC Health Serv. Res.	Australia	Single disease	Western A using lon populatio
Development of a specialty intensity score to estimate a patient's need for care coordination across physician specialties	Hodgson[68]	2021	Health Sci Rep	US	General population	Inpatient; Medicare sample of beneficia
Associations among claims-based care fragmentation, self-reported gaps in care coordination, and self-reported adverse events	Kern[3]	2024	BMC HSR	US	Single disease	REGARD communi Black and adults age (2003–20 30,239)
Overuse, underuse, and misuse: Improving	Kwiatkowski[69]	2022	Nurs Forum	US	General population	Adult pri patients a

effective primary care at a Federally Qualified Health Center						Health Ce predomin uninsured underinsu
A new measure for continuity of care: The alpha index	Lou[70]	2000	Health Serv Outcomes Res Methodol	US	General adult population	Methodol empirical
Lower fragmentation of coordination in primary care is associated with lower prescribing drug costs – Lessons from chronic illness care in Hungary	Lublóy[71]	2017	Eur J Public Health	Hungary	Single disease	Hungaria ≥40 years diabetes r and speci (2010–20
A new method for measuring continuity of care in family practice residencies	Magill[72]	1987	J. Fam. Pract.	US	General population	Family pr residency patients w over a 2-y
Evaluation of Physician Network-Based Measures of Care Coordination Using Medicare Patient-Reported Experience Measures	Moen[73]	2019	J Gen Intern Med	US	General population	U.S. Med beneficia physician practices, CAHPS a claims (2
Evaluating breast cancer care coordination at a rural national cancer institute comprehensive cancer center using network analysis and geospatial methods	Moen[74]	2019	Cancer Epidemiol Biomarkers Prev	US	Single disease	NCI-desig Compreh Cancer C women di with brea 2011–201 2,507)
Impact of the abolition of copayments on the GP-centred coordination of care in Bavaria, Germany: analysis of routinely collected claims data	Olm[75]	2020	BMJ Open	Germany	General population	Routine d BA SHIP
Comorbid condition	Snyder[76]	201	J Cancer Surviv	US	Single	Cancer su

care quality in cancer survivors: role of primary care and specialty providers and care coordination		5			disease	diagnosed 3 years p (SEER–M
Measuring provider continuity in ambulatory care	Steinwachs[77]	1979	Medical Care	US	Single disease (hypertension pilot)	Ambulato hypertens
Validation of 2 new measures of continuity of care based on year-to-year follow-up with known providers of health care	Tousignant[78]	2014	Ann Fam Med	Canada	General population	Patients v or cardiov disease
Continuity of health care: measurement and application in two rural counties of Guangxi Province, China	Wei[79]	2023	BMC Health Serv. Res	China	General population	Rural pri and comm services i counties Province
An interpersonal continuity of care measure for Medicare Part B claims analyses	Wolinsky[80]	2007	J Gerontology	US	General population	Adults ag participat health su linked M claims
Intensive Outpatient Program Effects on High-need Patients' Access, Continuity, Coordination, and Engagement	Wu[81]	2018	Med Care	US	General population	Patients i ImPACT multidisc interventi facility in Californi
Continuity index measures in the acute care hospital setting: An analytic review and tests using electronic health record data and computer simulation	Yao[82]	2018	J. Nurs. Meas.	US	General population	Hospitali in acute c (nursing

Synthesis of mapped measures

Table 4 summarises the results of the mapping; full descriptions of each measure are provided in Supplemental Material 4 (Table S1).

Many entries in the included set are indicator sets or bundles rather than single named instruments (for example, Aller et al., 2015[46] comprises two indicator sets totalling 21 individual items; the indicators are set out in Supplemental Material 5, Table S2). In the domain-by-domain synthesis below, each entry is referenced by lead author and year, with constituent items described in the corresponding entry in Supplemental Material 4 (Table S1).

Of the 64 measures identified, the greatest numbers mapped to the ATLAS Activities of Accountability and of Monitoring, follow-up and response to change (n=17 each), followed by relational continuity (n=16). Information transfer accounted for 12 measures, and cross-setting transitions of care for 10. Among ATLAS Approaches, Health care home (n=13) was the most frequently represented, with Health IT-enabled communication accounting for 9 measures. Overall, more than half of all measures mapped to more than one domain (see Overlap section below).

Table 4: Measures mapped to the care coordination and relational continuity domains (n = 64)

Category			Number of measures mapped to the domain	n (%)	Direct* n
ATLAS Activity[1]	Accountability	*Establish accountability or negotiate responsibility*		17 (27%)	4
		Align resources with patient and population needs		6 (9%)	2
	Communication	*Interpersonal communication*		10 (16%)	1
		Information transfer		12 (19%)	9
	Transitions of care	*Across settings*		10 (16%)	8
		As coordination of needs change		10 (16%)	9
	Care planning	*Assess needs and goals*		1 (2%)	0
		Create a proactive plan of care		0 (-)	0
		Monitor, follow up and respond to change		17 (27%)	6
	Patient centredness	*Support self-management goals*		2 (3%)	0
		Linking to community resources		0 (-)	0
ATLAS Approach[1]	Teamwork			5 (8%)	3
	Care management			4 (6%)	0
	Medication management			5 (8%)	2
	Health IT-enabled communication			9 (14%)	0
	Health care home			13 (20%)	0
Relational continuity[23]				16 (25%)	0

Percentages are of the 64 included measures; measures may map to more than one domain, so percentages do not sum to 100%.

* Direct: the measure explicitly assesses the named construct (e.g. an accountability action or a transition record); Indirect: the construct is inferred from patterns such as repeated provider contact. Continuity and concentration indices, and other proxy measures, are classified as indirect because they infer the construct rather than observing it; relational continuity therefore has no direct measures.

The ATLAS Activities

ATLAS Activity: Accountability

Establish accountability or negotiate responsibility (n=17; direct n=4)

Measures mapped to accountability most commonly inferred responsibility indirectly through visit-based continuity (i.e. patients repeatedly seeing the same clinician) and organisational stability (i.e. patients remaining attributed to the same organisation over time), assuming that repeated contact with the same clinician, team, or organisation reflects sustained responsibility for care.[47,62,80] A smaller subset of measures captured explicit accountability actions at key points in care, including discharge processes specifying follow-up responsibility, transmission of responsibility information at care transitions, and sustained case-management involvement indicating designated coordination responsibility.[52,58,63] Where measures captured sustained case-management involvement,[58,63] the case manager was implicitly identified as the accountable party; in measures of discharge or transition records, the existence of the document was assessed rather than who was named as responsible. Other measures reflected discrete accountability-related actions, such as referral gatekeeping or completion[75] follow-up of missed appointments[58] and organisational attribution or service-switching over time.[47] Further indicators inferred accountability through provider attribution: measures of continuity at the level of an individual clinician or their patient panel (i.e. how consistently a patient saw the same provider or a small set of providers), continuity of care for a specific condition, and indicators of formal enrolment with a primary care provider or telehealth service.[59,65,81]

Align resources with patient and population needs (n=6; direct n=2)

Measures were predominantly population-level and derived from utilisation patterns, service organisation, or predicted need. Most indicators inferred alignment indirectly by identifying patterns consistent with underuse, overuse, or dispersion of care, rather than directly assessing appropriateness.

Two measures provided direct indicators of resource alignment and were of particular interest. The Cover Index quantified the proportion of time a patient was without an actively practising usual provider, as an indicator of potential underuse.[67] The Preclinical Care Coordination Tool (PCCT) captured anticipatory coordination activity prior to clinical encounters using record-based indicators of proactive care preparation.[69]

Other measures assessed alignment indirectly through utilisation-based indicators of service organisation and predicted need, including claims-based dispersion measures and indicators of the variety of services received.[63] The Specialty Intensity Score (SIS) estimated predicted specialist need using diagnostic data to support population stratification and targeting.[68]

Atlas Activity: Communication

Interpersonal communication (n=10; direct n=1)

One measure directly indicated interpersonal communication, capturing direct contact between hospital and primary care professionals before discharge as part of a coordination indicator set. The remaining mapped measures inferred communication indirectly through continuity, referral, and network-based proxies, reflecting structural

conditions that may support communication but do not observe whether communication occurs, its quality, or the directionality of information exchange.

Several measures used visit-based continuity (continuity calculated from patterns of visits to the same provider, often used as a proxy for the underlying relational continuity captured in Haggerty's framework) as a proxy for interpersonal communication, including sequential, concentration, and usual-provider continuity indices.[53,62] Other measures operationalised communication through the connectedness of care networks, using physician network density, clustering, and patient-sharing metrics to characterise how interconnected clinicians are.[73,74] A referral-based measure captured whether specialist care was accessed through GP referral rather than direct access, as an indicator of coordination between primary and specialist care, though it did not directly observe communication processes.[75]

Information transfer (n=12; direct n=9)

Information transfer was the most directly measured communication sub-domain, with most measures observing whether information was created, transmitted, or made available rather than inferring it from patterns of contact. Direct measures captured discrete information artefacts at points of care: structured psychiatric transition records assessing both the creation of a discharge record and its transmission within a defined time window,[52] and coordination indicator sets documenting the presence and exchange of clinical information across providers.[46] Cancer screening pathways contributed several direct indicators of information availability, including referral adequacy following an abnormal result, delivery and accessibility of diagnostic reports, completeness of

444 screening records in the electronic record, and waiting time to referral.[51] A clinician-
445 reported measure of EHR integration captured the extent to which records were
446 connected across settings to support information sharing.[66]

447 A smaller number of measures inferred information transfer indirectly, using patient-
448 sharing and dispersion metrics, such as care density and the Herfindahl–Hirschman
449 Index, where the structural distribution of care across providers was taken to reflect the
450 likely need for, or occurrence of, information exchange.[54] Unlike most coordination sub-
451 domains, information transfer was therefore captured predominantly through direct
452 indicators, reflecting the visibility of documentation and record-transmission events in
453 routine data.

454 *Atlas Activity: Transitions of care*

455 Across settings (n=10; direct n=8)

456 Measures focused on hospital discharge and referral processes, capturing whether
457 responsibility and information were transferred reliably and whether timely follow-up
458 occurred. Admission as a transition event was not represented; admissions appeared as
459 the starting point for post-discharge measurement rather than as a coordination event in
460 its own right. Direct measures were common, reflecting the visibility of discharge
461 artefacts and post-transition events in routine data.

462 Several measures assessed discharge and referral processes by examining the creation,
463 transmission, and receipt of transition information, including structured transition records
464 and audits of hospital–primary care documentation.[46,52] Cross-setting transitions were also

operationalised through cancer screening pathways, using indicators of referral adequacy and waiting time to referral as markers of coordination between services.[51] Together, these measures conceptualised transitions as high-risk points requiring reliable handover and early continuity.

Other measures captured transitions indirectly through enabling infrastructure and service organisation. These included referral-based measures of cross-setting coordination and post-discharge follow-up, which reflect transitions without directly observing the transition event.[75,81] Several of these measures also appear in the Information transfer section, reflecting the inherent overlap between transitions and the information artefacts that document them; this is examined further in the synthesis of cross-cutting measures below.

As coordination needs change (n=10; direct n=9)

Measures were predominantly event-triggered, capturing responsiveness following discharge, risk identification, screening results, or pathway escalation. Most indicators assessed whether coordination activities intensified or adapted at expected transition points, rather than whether coordination was dynamically reconfigured over longer periods.

Several direct measures assessed responsiveness following changes in clinical risk or care phase, including cancer screening indicators of referral adequacy and waiting time,[51] early follow-up after hospital discharge,[81] and structured transition records capturing timely creation and transmission of discharge plans.[52] Organisational coordination

measures similarly reflected structured systems intended to support continuity during periods of elevated need.[48]

Fewer measures captured sustained adaptation of coordination over time. These included case-management continuity over a twelve-month period.[63] Other measures contributed indirectly, reflecting general coordination quality or access mechanisms rather than dynamic adjustment of coordination intensity.[46,81]

Atlas Activity: Care planning

Assess needs and goals (n=1; no direct)

The single measure was indirect, operationalising need through diagnosis-based prediction of specialist involvement.[68] No measures directly captured patient goals, shared decision-making, or goal-concordant planning.

Create a proactive plan of care (n=0)

No measures mapped to proactive care planning. No measures captured proactive coordination activity, such as anticipatory planning to prevent common adverse outcomes or named risks; the available measurement evidence focused on responding to identified events rather than anticipating them. This highlights limited routine-data coverage of anticipatory care planning as conceptualised in the ATLAS framework.

Monitor, follow up, and respond to change (n=17; direct n=6)

Measures spanned direct, event-triggered follow-up indicators and indirect proxies reflecting continuity, fragmentation, and provider connectedness. Direct measures most

captured observable follow-up actions after events signalling clinical change or elevated risk, including missed appointments, abnormal tests, medication changes, emergency department attendance, and hospital discharge.[52,58,79,81]

Other measures inferred monitoring more indirectly through longitudinal patterns of provider contact and service organisation, including a reversed concentration index of care fragmentation and patient-sharing network metrics describing connectedness among providers.[3,73] Additional indicators reflected the frequency and intensity of contact with services, and continuity within teaching-clinic models.[63,64]

Atlas Activity: Patient-centredness

Support self-management goals (n=2; no direct)

No measures directly captured self-management support as defined in the ATLAS, such as education, coaching, skills development, or goal setting. Instead, the two mapped measures, post-discharge follow-up at 7 and at 30 days, inferred self-management support indirectly through follow-up that may facilitate navigation and continuity.[52] This indicates limited routine-data capacity to capture the patient-facing content of self-management support.

Linking to community resources (n=0)

No measures were mapped to linkage with community resources, representing a clear gap in routinely collected indicators for this patient-centred coordination activity.

Summary of ATLAS Activities

Overall, measures were concentrated around coordination activities that generate observable events or documentation within routine data, including information transfer, accountability, transitions of care and follow-up. By contrast, activities central to person-centred care, including proactive care planning, support for self-management and links with community resources, were rarely or not represented. This suggests that routine data currently capture coordination as recorded healthcare activity rather than the broader relational and anticipatory work involved in coordinating care for people living with MLTC.

The Atlas Approaches

Measures mapped to approaches tended to capture structural features of care organisation, continuity, and system capacity that may enable delivery of multiple coordination activities, rather than reflecting discrete coordination events.

Teamwork (n=5; direct n=3)

Measures mapped to teamwork were of two kinds. Some directly assessed teamwork practices, notably an index of organisational coordination strategies including shared care plans and coordinated practices across providers,[48] and one structured indicator set.[46] Others were derived from patient-sharing network methods that infer teamwork through structural connectedness between clinicians, using metrics such as care density[54] (how many patients on average are shared between pairs of clinicians) and clustering (how often clinicians sharing patients with one clinician also share patients with each other), reflecting assumed opportunities for collaboration and communication.[73,83]

Some network-based measures have been validated against patient-reported indicators of clinicians working together, strengthening their interpretation as teamwork proxies despite reliance on indirect structural assumptions.[73] Overall, these measures did not capture the content or quality of teamwork but inferred its presence through connectedness within care networks.

Care management (n=4, direct n=0)

Measures mapped to care management reflected structured coordination support for patients with ongoing or complex needs. These included sustained case-management involvement, event-triggered follow-up following clinically meaningful change, and indicators of fragmentation in multimorbidity care that may signal a need for active management.[58,63,76] Overall, care management was operationalised as the presence of an organising coordination function rather than as specific care planning activities.

Medication management (n=5; direct n=2)

Measures mapped to medication management operationalised coordination through follow-up after changes to chronic medication[58] and after abnormal test results,[79] and through indicator sets and an organisational index covering medicines coordination across care levels.[46,48] These measures captured whether follow-up and medicines-related coordination processes occurred, rather than directly assessing medication reconciliation, patient engagement, or shared decision-making around medicines. One included measure assessed whether medication reconciliation systems were embedded at care transitions, drawing on survey or structured-coding capture rather than routinely collected data; measures of reconciliation accuracy derived from routine data remain uncommon.

Health IT-enabled communication (n=9; no direct)

Measures mapped to health IT-enabled communication captured the presence of infrastructure supporting electronic exchange and documentation, rather than observed communication behaviour. These included organisational health information technology (HIT) and health information exchange (HIE) capability, composite indices reflecting readiness for electronic information sharing, and structured EHR documentation and exchange practices.[60] Electronic reporting of results within cancer screening pathways[51] and a structured pre-clinic coordination tool[69] similarly reflected IT-enabled processes that may support coordination, without directly assessing information exchange.

Health care home (n=13; no direct)

Measures reflected the presence of a stable clinician or organisational home responsible for coordinating care over time. Operationalisation relied primarily on continuity, attribution stability, and persistent dominant-provider involvement, calculated from patterns of contact in claims or EHR data, rather than explicit assessment of care planning or communication processes.

This approach was represented through a range of longitudinal continuity constructs. These included measures identifying the clinician with whom a patient had the largest share of contacts for chronic care,[65] measures of year-to-year stability in the identity of that lead clinician or in the surrounding provider network,[78] and measures of organisational attribution stability quantifying whether the patient remained registered or attributed to the same practice or organisation over time.[47] Additional measures

conceptualised the health care home through duration-based continuity, capturing persistence of responsibility over multiple years.[56]

Relational continuity (n=16; no direct)

In the mapped literature, relational continuity was not assessed directly in terms of trust, accumulated knowledge, or perceived relationship quality. Instead, it was represented through claims- and EHR-based structural proxies capturing repeated encounters with a usual provider or stable provider set.[23]

Measures operationalised relational continuity primarily through visit concentration and dispersion indices, including usual-provider and interpersonal continuity measures, which infer relational continuity from dominance of a single clinician or small provider group.[62,65,80,82] A second group of measures captured relational continuity through dispersion of visits across multiple providers, using concentration and fragmentation indices, including the K index,[61] and sequential continuity metrics.[53,62]

Fewer measures incorporated a stronger temporal dimension, operationalising relational continuity as persistence of provider relationships across years rather than within a single observation window. These included known-provider continuity measures and duration-based indices capturing year-to-year stability and length of ongoing relationships.[56,78]

Overall, relational continuity was most often operationalised through patterns of visit clustering with a single usual provider (concentration measures) or distribution across multiple providers (dispersion measures), with fewer measures capturing explicit persistence over time. Interpretation is therefore context-dependent, particularly for

611 people with multiple long-term conditions, where appropriate multidisciplinary
612 involvement may reduce continuity scores despite sustained relational care within
613 primary care. For this population, appropriate multidisciplinary involvement (e.g.
614 consultations with several specialists for different conditions) may reduce visit-based
615 continuity scores even when relational care from a primary care clinician remains strong
616 and sustained. The same measures can therefore signal weak continuity in one population
617 and appropriate cross-condition involvement in another, depending on context.

618 *Overlap of measures across multiple domains*

619 A key finding from the mapping was that many measures aligned with more than one
620 care coordination activity or approach, reflecting both conceptual overlap between
621 coordination domains and the way routine-data measures operationalise multiple
622 coordination activities simultaneously.[1,23] Measures based on visit concentration,
623 relational continuity, and provider connectedness commonly mapped across domains
624 including accountability, interpersonal communication, monitoring and follow-up,
625 transitions of care, and relational continuity.

626 Twenty-seven measures (42%) mapped to a single domain or approach, while the
627 remaining 37 (58%) aligned with two or more domains. Twenty-eight measures (44%)
628 mapped to two or three domains, and nine (14%) mapped to four or more domains. Most
629 of these broader measures mapped to four domains (n = 7); one mapped to five, and the
630 Aller Care Coordination Indicator Set (clinical management) mapped to eight.

631 For example, visit-based continuity and concentration measures (e.g. usual-provider,
632 continuity, and sequential continuity indices) mapped across multiple domains because

repeated contact with the same provider can plausibly indicate sustained responsibility, enable ongoing interpersonal communication, and support follow-up and responsiveness over time. Overlap was also evident for network-based measures, such as care density and physician network clustering, which mapped to both activity domains (e.g. interpersonal communication and information transfer) and ATLAS approaches (e.g. teamwork). This cross-mapping reflects that the same network metric can serve different measurement purposes, rather than implying that coordination is differently constituted in different network contexts. Measures derived from discharge, referral, and follow-up processes similarly mapped across transitions of care, information transfer, accountability, and monitoring domains, depending on whether emphasis was placed on handover, responsibility, or timely response.

Overall, this pattern indicates that coordination domains are not easily separable in routine data, with many measures functioning as cross-cutting indicators of overall coordination quality rather than discrete coordination activities. The mapping therefore highlights the need for cautious interpretation of domain-specific findings and transparency in how measures were assigned and interpreted across domains.

Summary of ATLAS Approaches

Measures mapped to coordination approaches were predominantly structural proxies, describing stable provider relationships, connected care networks or information infrastructure rather than directly measuring coordination processes. These approaches therefore appear to represent the organisational conditions that may support coordinated care rather than coordination itself.

Discussion

Principal findings

This review identified three principal findings. First, routinely derived measures of care coordination were numerous but unevenly distributed across coordination domains, predominantly capturing observable, documentable coordination activities while under-representing anticipatory, person-centred and self-management aspects of care. Second, care coordination for people living with MLTC was shown to be inherently multidimensional, with substantial overlap between measures indicating that coordination domains are not easily separable in routine data. Third, although EHR-derived indicators captured many observable coordination processes, several important aspects of care coordination could not be directly measured. Further work is therefore needed to determine the extent to which meaningful assessment can be achieved using EHR-derived measures alone, or whether they are best interpreted alongside patient-reported measures. The stakeholder-informed mapping that underpins this review is reported in full elsewhere.[26]

Unlike previous reviews, this review did not simply catalogue measures of care coordination. By systematically mapping routinely derivable measures against the AHRQ Care Coordination Atlas and relational continuity, it demonstrates where routine electronic health record data can meaningfully capture care coordination, where important measurement gaps remain, and where existing measures simultaneously represent multiple coordination constructs.

This scoping review identified 64 unique measures of care coordination and relational continuity of care that can be derived from routinely collected data. Although measures captured multiple dimensions of coordination and continuity, their distribution across domains was uneven. Measures were predominantly aligned with domains capturing longitudinal responsibility and sustained contact, typically at the level of an individual usual clinician (e.g., accountability and relational continuity), and with activities that yield observable documentation, such as information transfer, monitoring and follow-up, and transitions across settings. Coordination of contact tended to be captured at the level of an individual physician, specialist, or general practitioner, with multidisciplinary team involvement largely inferred from network-based measures rather than directly assessed. Routine data, therefore, picks up coordination as measurable events, recorded documentation, or patterns of service utilisation, leaving more person-centred and non-clinical aspects of coordination less visible. Domains central to anticipatory and person-centred coordination, including proactive care planning, assessing needs and goals and supporting self-management, were under-represented. No measures captured linkage with community resources or aspects of social care, and patient experience and functional outcome measures were similarly absent. Coordination for people with MLTC, where the central question is often whether a single clinician (typically in primary care) holds responsibility across multiple condition reviews, is therefore only partially visible in the available measurement evidence. The concentration of measures in accountability and relational continuity reflects what routinely collected data most readily captures, rather than necessarily what matters most for coordinating care for people with MLTC.

Our first finding, that routine-data measures cluster around observable coordination activities, reflects the types of information routinely recorded within healthcare systems. A key finding was the substantial overlap between measures across coordination domains. More than half of the included measures (37 of 64) mapped to two or more domains, with nine mapping to four or more. This pattern indicates that coordination domains are not easily separable in routine data, with many measures functioning as cross-cutting indicators of overall coordination quality rather than as discrete activity measures. Visit-based continuity indices and patient-sharing network metrics served as flexible structural indicators that could be read as evidence of accountability, interpersonal communication, monitoring and follow-up, or relational continuity, depending on the analytic emphasis applied. This cross-cutting property reflects both the overlapping nature of coordination constructs and the reliance on proxy indicators in routinely collected data, and represents the main methodological insight from the mapping. Applying this classification, most measure-to-domain mappings were indirect rather than direct (93 of 137 mappings; 68%): coordination was more often inferred from patterns of contact or from structural features of the data than recorded as an observed coordinating action. This reinforces the observation that routinely collected data captures the traces of coordination more readily than coordination itself.

Use of measures in comparison to existing literature and frameworks

Previous reviews have catalogued care coordination measures or examined continuity of care within specific clinical settings. This review extends that work by focusing specifically on routinely derivable measures relevant to MLTC, mapping them against an

established coordination framework and examining how individual measures relate to multiple coordination domains.

Our second finding concerns the multidimensional nature of care coordination. Definitions of care coordination and continuity are complex and contested,[2,84] and may be conceptualised from multiple perspectives across health care, social care, and their integration. As a result, no single measure can fully capture coordination. Comprehensive measurement may therefore require combining patient-reported outcome measures (PROMs), patient-reported experience measures (PREMs), structural process indicators, and both direct and indirect markers derived from EHRs.

Our third finding highlights both the strengths and current limitations of EHR-derived indicators. Care coordination is more commonly operationalised indirectly than directly in routinely collected data. Proxy-based measures such as continuity indices and concentration measures provide scalable indicators of stability and dispersion of care, but they do not directly assess whether coordination processes occurred, nor whether coordination was appropriate or experienced as coherent by patients.[46]

Whether some constructs can be recovered from routine data at all is an open question. Wolinsky and colleagues developed one of the interpersonal continuity measures included here;[80] seven years later, in a study on which Wolinsky was a co-author, the same group concluded that interpersonal continuity cannot be validly measured from claims data.[85]

Several continuity indices depend on a parameter the measure itself does not fix and the analyst must choose: the number of available providers in LICON,[77] the weighting in the Alpha Index,[70] the continuity-determining period in Eriksson and Mattsson's fraction-of-

742 care measure,[62] and the interval threshold in Wolinsky's index.[80] The choice can dominate
743 the result. When Wolinsky varied the threshold from 4 to 16 months, estimated continuity
744 ranged from 4.3% to 26.4% for the same primary care physician, and from 6.0% to
745 36.4% for any physician.[80] Where such values are not reported, estimates from different
746 studies may not be comparable.

747 The problem is not confined to parameters the measure leaves open. Where a value is
748 specified, it still shapes the estimate: Cheng's index scales with the look-back period,[56]
749 and Coleman reports a 28-day follow-up window having also examined 14 and 21 days.[58]
750 Benjenk goes further, reporting follow-up after hospitalisation at 7 and 30 days as
751 separate measures.[52] Two measures sharing a name but differing in their parameter values
752 are not the same measure and cannot be treated as interchangeable.

753 A further consideration concerns the gap between a measure’s specification and whether
754 it can be computed from the data available in a given setting. One included indicator set
755 specified a medication-coordination measure, documented primary care follow-up within
756 one week of hospital-initiated insulin, that could not be computed in any of the study’s
757 care settings, because the patients it applied to could not be identified from the data held
758 at the time. This is a limitation of data availability and maturity rather than of the measure
759 itself. Because the capture, structure and linkage of routinely collected electronic data
760 vary across settings and continue to develop over time, a measure that cannot be derived
761 in one system, or at one point over time, may become feasible in a more data-mature
762 setting, or as record-systems evolve. Feasibility charted from the included studies should
763 therefore be read as specific to their data environments rather than a fixed property of the
764 measure. Moreover, structural or process indicators derived from EHR data do not

necessarily correspond to a patient's subjective experience of coordinated care. Key influences on coordination, such as health literacy, relational trust, clinician knowledge of local systems, and interpersonal communication,[86] are rarely captured in structured data fields, limiting interpretation of routine indicators. The coverage of EHR data also varies across the care pathway: some community and social care services remain paper-based or are not linked to mainstream EHR systems,[87] rendering coordination activities in these settings invisible to measures derived from claims and EHR data. Patients themselves may not always be aware of the coordination processes happening on their behalf, so even patient-reported measures cannot fully observe all coordination work.

A further limitation of routinely available measures is their orientation toward responding to events rather than anticipating them. The included measures captured coordination activity after triggers (post-discharge follow-up, response to risk identification, completion of referrals) but not coordination activity in advance of events, such as anticipatory planning to prevent common adverse outcomes or identification of patients before crisis points. Support for patient self-management, an increasingly central component of UK care strategies for people with MLTC, was similarly absent from the available measurement evidence. These gaps mean that the measurement landscape currently emphasises measurable events and documented handovers rather than the anticipatory, person-centred, and self-management-oriented elements of coordinated care that policy and practice increasingly seek to deliver.

For people living with MLTC, the challenge of designing measures to capture coordination is particularly important. These individuals frequently receive care across multiple settings and specialties and may face physical, cognitive, or mental health

barriers that limit their ability to coordinate their care, increasing the burden on family carers. Conversely, poor coordination itself adds to the treatment burden experienced by people with MLTC, who must manage appointments, medications, and care plans across multiple providers. Measures of care coordination developed for single-disease pathways may therefore be poorly suited, both substantively, because they assume a single condition or provider relationship, and methodologically, because routine measures of relational continuity, often based on visit patterns, may be reduced by appropriate multidisciplinary involvement, paradoxically yielding lower continuity scores for patients receiving more comprehensive, cross-specialty care; the relationship between continuity indices and adverse outcomes has also been shown to vary with the number of chronic conditions and with the index used.[88] Moreover, their alternative, coordination and continuity PROMs, do not consistently correlate with improved outcomes[89] and require additional data, which may be resource intensive and difficult to implement at scale.

Given the growing population with MLTC and the association between continuity of care and outcomes, including mortality,[29,90–92] measures compatible with routinely collected data could offer a practical means of identifying patterns of high fragmentation or low continuity, supporting both further investigation and longitudinal monitoring of integrated care initiatives. However, they do not replace patient-reported coordination and experience measures (PROMs and PREMs), which capture aspects of coordination quality, such as trust, perceived continuity, accessibility, and the sense of being known, that are not accessible through routine data.[93] Routine-data measures and patient-reported measures address different questions and should be interpreted together; discrepancies between them may themselves be informative and warrant further exploration. Further

work is needed to determine whether meaningful assessment can be achieved using EHR-derived measures alone, or whether routine and patient-reported measures should be used in combination. These findings also have practical implications for Integrated Care Systems and commissioners seeking to evaluate coordinated care for people living with MLTC. Rather than relying on a single indicator, routine evaluation is likely to require a small suite of complementary measures spanning continuity, accountability, information transfer and care transitions, alongside patient-reported measures where appropriate.

Strengths and limitations

Key strengths of this review are its international scope and its explicit focus on measures that can be derived from routinely collected electronic data, thereby informing consideration of their potential applicability to UK electronic health records.[94] The most comprehensive prior review of the coordination measurement landscape identified 96 measure instruments, of which 84 relied on survey data and one on administrative data alone;[2] this review is restricted to measures derivable from data already recorded in routine care.[95] Moreover, organising the findings using the AHRQ Care Coordination Atlas,[1] supplemented by relational continuity informed by PPIE and stakeholder insights, provided a structured and theory-informed framework for synthesising a diverse evidence base.

However, there are important limitations. First, the review focused on measures described in the literature as coordination or continuity measures; it did not extend to closely related constructs that may shape coordination experiences (e.g., health literacy, social

deprivation, psychological resilience;[25,28,86]). This was a deliberate scope decision, but readers should be aware that the picture presented here is bounded by it.

Second, the mapping of measures to AHRQ Care Coordination Atlas domains and relational continuity required reviewer judgement, since measures were not developed by their original authors with this framework in mind. Domain assignments were made using predefined criteria (Table 1), with disagreements resolved through discussion. However, the mapping should be interpreted as a consistent framework for comparison rather than a definitive categorisation, as original authors may have described their measures differently.

Third, the included literature was predominantly US-based, which likely reflects the longer history of EHR adoption and tariff-based care delivery in that system. The applicability of US-developed measures to other health systems is not straightforward and warrants caution. Routinely-collected data structures, the way care is paid for and attributed to providers, and the prevailing models of primary and integrated care vary substantially across health systems, affecting whether US-derived measures can be applied in other settings and how their scores should be interpreted. International comparison studies, applying the same measures across systems, could clarify which measures are robust to such differences and which require system-specific adaptation. In the meantime, the US literature provides a useful set of reference exemplars rather than a directly transferable measurement library.

Fourth, the review charted the populations represented in included studies but did not systematically extract the specific clinical conditions or condition combinations to which

each measure has been applied. The evidence base is therefore likely uneven across the MLTC landscape, with some clinically important configurations, notably the mental–physical health interface, dementia in community settings, and severe mental illness with comorbid physical conditions, likely underrepresented in the measurement work to date.

Fifth, the review did not systematically extract equity-relevant features of the included measures, such as their applicability across demographic groups or performance in underrepresented populations. Primary studies rarely report this information consistently, limiting what could be extracted. We also did not systematically extract intersectional characteristics of study populations and therefore cannot determine which combinations of identity, condition, and context are well represented in current routine-data measurement, and which are not. This is an important gap for future equity-focused measurement work in MLTC populations, where those most affected by poor coordination are often the least visible in research.

Sixth, feasibility and validation were charted as reported by the source studies rather than independently assessed. A measure was recorded as validated where a credible source tests its construct validity, judged from the published account; we did not evaluate the adequacy of those tests. Feasibility likewise reflects what each study reported about its own data environment.

Implications for future research

This review provides a structured foundation for a staged programme of measure development. The pathway from this review to implementation is likely to involve four stages: (1) co-developing and prioritising candidate measures with stakeholders; (2)

refining measures to address important gaps in coordination identified in this review; (3) evaluating their feasibility and performance within routine EHR datasets across different healthcare settings; and (4) validating the resulting measurement set against patient-reported coordination outcomes before implementation for service evaluation and quality improvement. Particular attention is needed to coordination activities not well captured in current routine-data measures, including anticipatory care planning, support for patient self-management, linkage with community resources, and coordination across health and social care. Some of these gaps reflect what EHR systems currently capture; others reflect what EHR systems could capture if configured differently. Identifying which coordination activities should and could be recorded in routine systems, and what infrastructure changes are needed to support this, is a priority for future work and for those commissioning EHR redesign. The cross-cutting nature of the included measures, alongside the dominance of US-based literature, suggests that coordination measurement may need to be designed with explicit attention to local network and care configurations rather than expecting a single set of measures to perform equivalently across health systems. Whether routine-data measures can be translated across health systems, or whether they should be read only in a single-system context, is itself an empirical question that international comparison studies could help to answer.

A meaningful measurement set could ultimately support several practical goals: reducing treatment burden for people with MLTC by identifying coordination failures earlier; evaluating the impact of integrated care initiatives at scale; and underpinning commissioning and quality improvement decisions with consistent measurement

evidence. Any constructed measures will need external validation, including against patient-reported coordination outcomes, before being relied on for these purposes.

These findings also have practical implications for health systems seeking to evaluate integrated care, an undertaking in which evaluations have often produced context-dependent findings of limited use to practice.[96] Rather than relying on a single indicator of coordination, commissioners and integrated care systems are likely to require a small suite of complementary routine-data measures spanning continuity, transitions, accountability and information transfer, alongside patient-reported measures to capture aspects of coordination that remain invisible within routine data. The mapping presented here provides a transparent starting point for developing such a core measurement set.

Conclusion

Routinely derivable measures of care coordination are numerous but unevenly distributed across coordination domains, and tend to capture documentable events rather than anticipatory, person-centred and self-management activities. Most map to their domain indirectly: routine data records the traces of coordination more readily than coordination itself. No single standardised measure exists for people living with MLTC. Care coordination for people living with MLTC is inherently multidimensional, and the substantial overlap between measures demonstrates that coordination domains are not easily separable in routine data. Routine data measures could therefore be developed to support evaluation of coordination at scale, but their limitations mean they should be interpreted alongside patient-reported measures of coordination and experience.

List of abbreviations

Abbreviations

AHRQ – Agency for Healthcare Research and Quality

AI – Artificial Intelligence

CAHPS – Consumer Assessment of Healthcare Providers and Systems

CNC MLTC – Cross-NIHR Collaboration for Multiple Long-Term Conditions

COPD – Chronic Obstructive Pulmonary Disease

CPRD – Clinical Practice Research Datalink

EHR – Electronic Health Record

EMR – Electronic Medical Record

GP – General Practitioner

HIE – Health Information Exchange

HIT – Health Information Technology

HMO – Health Maintenance Organization

JBI – Joanna Briggs Institute

MLTC – Multiple Long-Term Conditions

NCI – National Cancer Institute

NHS – National Health Service

PCCT – Preclinical Care Coordination Tool

PCC – Population, Concept and Context

PPIE – Patient and Public Involvement and Engagement

PRISMA-ScR – Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews

SEER – Surveillance, Epidemiology, and End Results Program

TNHI – Taiwan National Health Insurance

US – United States

VA – Veterans Affairs

VA-APCD – Virginia All-Payer Claims Database

VCFSE – Voluntary, Community, Faith and Social Enterprise

WHO – World Health Organization

Supplemental material

Supplemental Material 1: PRISMA-ScR checklist

Supplemental Material 2: Bibliographic database search strategies, additional keyword searching and grey literature search protocol

Supplemental Material 3: AI-assisted preliminary mapping: prompt, worked example and reviewer verification

Supplemental Material 4: Table S1. Care coordination and relational continuity measures included in the review

Supplemental Material 5: Table S2. Aller et al. (2015) care coordination indicator sets

Supplemental Material 6: Study selection audit log

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Author contributions

FD, PBu, KW, VD, KB, PBo, AC, HG, VG, RJ, KL, IM, RMM, BN, RP, SR, SS, and SC contributed to the conception and design of the study. VD coordinated all stages of the review. VD, AT and FD developed the methodology and search strategy. VD, NS, AT, FD, PBu and KW undertook study screening, data extraction, data charting and synthesis. VD, NS and AT mapped the measures to the care coordination domains and interpreted the findings. JB, VD, NS and AT facilitated expert stakeholder engagement and contributed to the interpretation of the findings, manuscript development and critical review. FD secured the study funding. FD and PBu provided overall supervision as joint Principal Investigators. VD, PBu and NS prepared the original manuscript draft. Initials distinguish Patrick Burch (PBu) from Peter Bower (PBo). All authors contributed to the interpretation of the findings, critically revised the manuscript for important intellectual content, approved the final version and agree to be accountable for all aspects of the work.

Statements and Declarations

Ethical considerations

This review synthesised published studies and documents and involved no human participants; ethical approval was therefore not required.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

Declaration of conflicting interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Data availability

All data generated or analysed during this study are included in this published article and its supplemental material. The record-level screening and eligibility decisions are provided in Supplemental Material 6, and the included measures with their domain mappings in Supplemental Material 4.

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1242

1243

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- 06SupplementalMaterial5TableS2AllerIndicators.docx
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