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SYSTEMATIC REVIEW

Process measures developed for the routine monitoring of low-value care with electronic health data: A scoping review

[version 1; peer review: 1 approved with reservations]

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Abstract

Background

Low-value care (LVC) are medical services where the potential harms or costs outweigh expected clinical benefits. Despite growing adherence to initiatives such as Choosing Wisely, approaches to routinely monitor and reduce LVC across healthcare systems remain limited. Process measures are particularly relevant for this goal, as they capture actions taken during care delivery and can inform de-implementation strategies.

Objective

To map the extent and nature of evidence on process measures developed to routinely identify or reduce LVC across healthcare systems.

Eligibility criteria: English-language sources across all healthcare services and patient populations were eligible. Sources reporting structure or outcome measures alone were excluded.

Information sources and methods: Searches were conducted on October 2025 in MEDLINE, CINAHL, Embase, Scopus, Web of Science, and grey literature sources with no restrictions on publication date. Two independent reviewers screened records and reports were extracted using a standardized form.

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1. **Rudolf Bertijn Kool**, Radboud University Medical Center, Nijmegen, The Netherlands

Any reports and responses or comments on the article can be found at the end of the article.

Results

Of 4,159 records identified, 14 sources published from 2014 to 2024 met inclusion criteria, mainly originating from Canada and the United States. A majority of process measures were used to identify or quantify LVC at regional or hospital locations and focused on screening overuse, redundant testing, or medication misuse. Measures were commonly operationalized using ratio-based algorithmic logic to support routine monitoring or benchmarking. Only one study reported routine process measurement within an active de-implementation strategy. Considerable heterogeneity was observed across measurement specifications, inclusion and exclusion criteria, data sources, and analytic approaches, limiting comparability across sources.

Conclusions

Process measures are used in a wide variety of settings to routinely monitor LVC; however, their design and application are heterogeneous, and they are rarely reported alongside de-implementation strategies. Greater taxonomy standardization, improved reporting transparency, and stronger alignment with quality improvement and behavioural change frameworks are needed to support systematic monitoring and subsequent reductions in LVC across healthcare systems.

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Keywords
Low-value care, process measure, routine monitoring, electronic health records, scoping review

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Introduction

Low-value care (LVC) refers to preventive, diagnostic, or therapeutic services that are overused, misused, or underused and where potential harms or financial costs outweigh expected clinical benefits. This includes the provision of ineffective, inappropriate, or non-cost-effective care, as well as the failure to deliver necessary services, with consequences for patients, healthcare professionals, and health systems.[1,2] Beyond its direct clinical and economic implications, LVC undermines key dimensions of the quadruple-value framework, including patient outcomes, patient experience, and cost efficiency.[3] Despite growing emphasis on value-based healthcare (VBHC), a persistent gap remains between the promotion of VBHC and the systematic reduction of LVC across healthcare systems, particularly within the Organisation for Economic Co-operation and Development (OECD).[4] To better connect these complementary aims, the ability to monitor LVC reliably and routinely across care settings in required.[5]

Addressing these goals can support the routine monitoring, benchmarking, and de-implementation of LVC on regional, national, and international levels as well as through inter-country comparisons.[2,6] To date, health systems and international bodies have undertaken efforts to monitor and minimize the impact of LVC,[7,8] including efforts embedded within the OECD Health Care Quality Indicator (HCQI) Framework, which aims to assess system-level efficiency and effectiveness.[9] However, understanding the scope and effectiveness of these LVC measures within routine health quality monitoring remains limited, reflecting multiple opportunities to better refine measurement standardization, data availability, and the systematic use of LVC process-based performance assessment.[2,4,10]

In this context, established frameworks of healthcare quality measurement offer a useful foundation for addressing these limitations and have been applied successfully to support continuous quality improvement using clinical indicators.[11] Among these, the Donabedian model assesses healthcare quality through structure, process, and outcome measures, where structure measures quantify available health system resources, process measures capture the actions taken during care delivery, and outcome measures assess the effects of care on patients' health.[12,13] In the context of LVC monitoring, process measures have been identified as particularly relevant as they directly track care provided and can be observed consistently across multiple health service settings.[14] Moreover, from an applied behavioural perspective, process measures can further inform de-implementation strategies by enabling analyses of care provider behaviour and the care pathway mechanisms that shape service delivery on a systems level.[15]

This utility of process measures is reflected in international initiatives such as Choosing Wisely, which has played a central role in the identification and monitoring of LVC across multiple OECD health systems.[16] The Choosing Wisely campaign, initiated in the United States in 2012, has since expanded to more than 30 countries, fostering global collaboration on defining LVC in concrete and measurable terms. Choosing Wisely recommendations encompass over 80 medical specialties and identify over 700 medical services deemed as low-value. A 2021 systematic review identified 131 sources that applied Choosing Wisely criteria across health settings to support interventions to reduce LVC, indicating wide adoption of Choosing Wisely criteria to frame LVC monitoring.[17] However, despite the wide adoption and evaluation of Choosing Wisely campaigns, the specific process measures used to operationalize routine LVC monitoring and to support de-implementation are often inconsistently defined and reported.[10,18] In addition, process measures of LVC are commonly validated using historical cohort data, thus, they are rarely designed for continuous monitoring, leaving a gap between measure validation and their routine use in quality improvement.[19,20]

The current study

Taken together, these limitations highlight the need for a clearer understanding of how process-based measures of LVC are defined and implemented within routine health system monitoring. To address these gaps, the present scoping review aims to identify, characterize, and categorize process-based measures that have been developed or applied in electronic health data to routinely detect or reduce LVC across primary, secondary, and tertiary healthcare settings. Specifically, this review seeks to map how process measures are operationalized, the data sources on which they rely, and the clinical or system-level purposes they serve, including routine monitoring, benchmarking, and de-implementation.

This review was structured around three objectives:

1) To identify and categorize existing process measures designed for routine monitoring of LVC across healthcare systems.

2) To identify variation in any reported application of these process measures, including differences across healthcare settings and data environments.

3) To map the reported goals of process measure use, e.g. to estimate LVC prevalence or to support de-implementation strategies.

Methods

This review was conducted in accordance with the Joanna Briggs Institute's methodology for scoping reviews.[21] The review protocol was registered with the Open Science Framework (OSF; https://doi.org/10.17605/OSF.IO/YMDVF).[22] Reporting followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines.[23]

Concept analysis

An operational definition of LVC encompassed treatments, diagnostic tests, medical interventions, or care processes that meet one or more of the following criteria: lack of effectiveness or minimal effectiveness, potential harms outweighing anticipated benefits, underuse or untimely use, poor cost-effectiveness,[2] or misalignment with recommended practices as defined by Choosing Wisely.[16] A process measure was defined as a measure that captures specific actions, decisions, or services delivered during the care process, reflecting what care was provided rather than the resources available (structure) or patient health outcomes (outcomes).[24] Further, "routine use" was defined as the application of process measures specifically developed for continuously updated data systems to enable ongoing monitoring or system-level assessment, rather than one-time analytic research applications.

Data sources and searches

A structured, multistage search strategy was employed to identify relevant published and grey literature sources pertaining to the use of process measures to routinely monitor or reduce LVC. An initial limited search was conducted on September 2025 in MEDLINE (via PubMed) and CINAHL (via EBSCO Host) to identify key sources, after which titles, abstracts, and indexing terms were examined to inform the development of a comprehensive search strategy. This strategy was developed in collaboration with an experienced health sciences librarian and was further adapted for each database to accommodate differences in indexing and syntax.

Finalized searches, conducted in October 2025, were applied across the following electronic databases: PubMed, Embase, Scopus, Web of Science, CINAHL, and the Cochrane Database of Systematic Reviews. Search terms incorporated controlled vocabulary (e.g., Medical Subject Headings) alongside free-text keywords and synonyms related to three core concepts: healthcare services or professionals, LVC, and process measurement. Given the high level of heterogeneity of terminology in this field, commonly used descriptors such as overuse, inappropriate, unnecessary, cost-ineffective, de-implementation, quality assessment, and Choosing Wisely were included to ensure broad capture of relevant sources. This inclusive approach reflects the absence of universally applied taxonomies for LVC and process measurement.

To enhance comprehensiveness, grey literature and unpublished source databases were also searched, including PROSPERO, the Open Science Framework registries, and Google Scholar (via incognito mode) for relevant institutional or policy reports as well as theses, protocols, trail registrations, and conference presentations. Citation chaining was undertaken by screening the reference lists of included sources and relevant reviews, and subject-matter experts were consulted where appropriate. Consistent with the protocol, only English-language sources were eligible for inclusion and all records published up to the final search date of 25 October 2025 were included.

Citation selection and screening

Sources were eligible for inclusion if they satisfied three criteria:

1) Assessment of LVC or any service synonymous with LVC (e.g., overuse, inappropriate use, cost-ineffective care, etc.).

2) Assessment of LVC by use of process measurement or via composite measure that included process measurement.

3) LVC process measures designed for routine monitoring (i.e., algorithm, indexing, processing logic, etc.) within electronic health data (i.e., health registry, insurance database, data warehouse, etc.).

In line with the objectives of a scoping review, no restrictions were applied regarding study design; therefore, quantitative, multi-method, and mixed-method evidence were eligible for inclusion. Sources for which the full text could not be retrieved were excluded. All records identified through the database and grey literature searches were imported into Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia) for reference management and screening. Duplicate citations were automatically removed via Covidence with additional duplicates identified and removed during subsequent screening processes.

Study selection was conducted in two sequential stages. First, two reviewers (LS and DF) independently screened titles and abstracts against the predefined inclusion criteria. Citations deemed potentially relevant or for which eligibility was unclear proceeded to full-text assessment. In the second stage, full texts of all potentially eligible sources were screened to confirm inclusion. Reasons for exclusion at the full-text stage were documented systematically. Any discrepancies between reviewers were resolved through discussion, or, when necessary, by consultation with a third reviewer (KH). The reference lists of all included sources and relevant reviews were also screened to identify additional sources; however, no additional sources were identified through this method. The overall study selection process was documented and is reported using a PRISMA-ScR flow diagram (see Figure 1).

Data extraction and synthesis

Data were charted using a predefined and piloted data extraction form, developed in accordance with the Population–Concept–Context framework and applied consistently across all included sources (see Extended Data available on the Open Science Framework: https://doi.org/10.17605/OSF.IO/Y7FR4). Extracted data included citation details, study design and setting, population characteristics, and the form of LVC addressed. For each source, detailed information was charted on process measure characteristics, including the purpose of measurement (e.g., identification, quantification, or reduction of LVC), data source (e.g., administrative claims, electronic health records, or clinical registries), measure definition, inclusion and exclusion criteria, and measurement approach. Where reported, information on implementation context, monitoring goals, de-implementation strategies, and reported effectiveness, limitations, or gaps were also extracted.

Data were synthesized using descriptive and framework-informed methods appropriate for scoping reviews. Extracted measures were grouped and summarized by healthcare setting, type of process measure, form of LVC assessed, and health data system used. All findings were presented in tabular and narrative formats to map how process measures are defined and operationalized across health systems. Consistent with JBI scoping review methodology, no formal assessment of methodological quality was undertaken.[21]

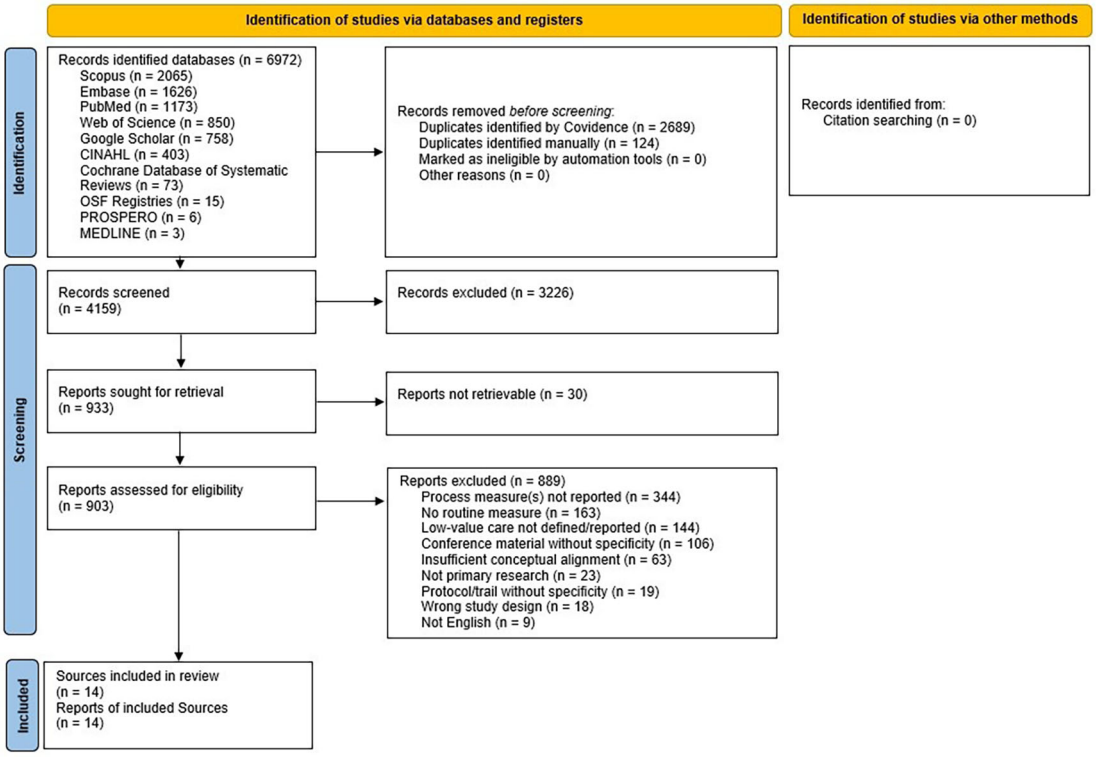


Figure 1. PRISMA-ScR flow diagram of source selection. Flow diagram illustrating the identification, screening, eligibility assessment, and inclusion of sources of evidence examining the use of process measures to identify or reduce low-value care using electronic data system.

Patient and public involvement

Patient and public involvement were not undertaken in the design, conduct, reporting, or dissemination of this review.

Results

Citation selection

The record searches identified 6,972 sources from electronic databases and registries, and through grey literature searches. After removal of 2,813 duplicate records, 4,159 titles and abstracts were screened. Of these, 903 sources were retrieved for full text assessment, and 889 were excluded for reasons including absence of a reported process measure, lack of relevance to LVC, or further insufficient conceptual alignments with the review objectives. In total, 14 sources met the criteria for data extraction and were included in the data extraction phase.[25–38] No additional sources were identified through citation searching, and no ongoing nor awaiting-classification sources were identified.

General characteristics of the included sources

An overview of the characteristics of the 14 included sources is presented in Table 1. These 14 sources were published between 2014 and 2024. Most sources originated from the United States (n = 9), followed by Canada (n = 4) and Australia (n = 1). All included sources employed quantitative designs, primarily using health registry or administrative data

Table 1. Characteristics of included sources of evidence.

Author (Year)	Country	Study design	Healthcare setting	Population	Data system
Adams (2023)[25]	USA	Prevalence study	Integrated system	Veterans Health Administration recipients	Insurance claims database
Adams (2023)[26]	USA	Prevalence study	VA system	Veterans Health Administration recipients	Health registry
Angiolillo (2019)[27]	USA	Prevalence study; Economic evaluation	Academic hospital	All surgical patients	EHR
Baek (2023)[28]	Canada	Prevalence study; Economic evaluation	Academic hospital	All Diabetes Type-2 patients	EHR
Boukar (2014)[29]	Canada	Cross sectional study; Systematic review	Inpatient hospital	Adult trauma	EHR
Brett (2017)[30]	Australia	Study protocol	System level	National population	EHR
Deshommes (2024)[31]	Canada	Cohort study; Multi-center	Pediatric trauma	Pediatric trauma	Health registry
Fleming (2022)[32]	USA	Multi-center; Prevalence study	Primary care	Medicare FFS beneficiaries	Health registry
House (2021)[33]	USA	Cross sectional	Pediatric hospital	General pediatrics	Health registry
Liu (2016)[34]	USA	Cohort study; Cross sectional	Community	General pediatrics	Insurance database
Lowe (2014)[35]	USA	Multi-center; Economic evaluation	Hospital	North Carolina statewide hospitals	Voluntary hospital database
Segal (2015)[36]	USA	Cross sectional	System level	Medicare recipients	Insurance database
Soltana (2021)[37]	Canada	Multi-center	Inpatient	Injury admissions	Health registry
Zhao (2022)[38]	USA	Case report	Community	Insured beneficiaries	Insurance claims database

Note. n = 14. EHR = electronic health record, FFS = Fee-for-service, USA = United States of America.

sources. Measures relied on constructed indexes, care process algorithms, and diagnostic coding ratios (i.e., ICD-10, ICD-11, AIS) that were operationalized across regional and national clinical data infrastructures.

The included sources covered a range of specific low-value practices across diagnostic testing, procedures, and prescribing practices. For example, several studies focused on overuse of screening procedures, such as colonoscopy in asymptomatic patients within U.S. veteran populations using registry data.[25,26] In primary care and community settings, repeat diagnostic testing, such as unnecessary repeat HbA1c measurements within short intervals was monitored using electronic health record (EHR) data across general patient populations.[28] Other studies addressed low-value prescribing and medication-related practices, including polypharmacy patterns (e.g., multiple concurrent prescriptions) in insured populations,[34] and misuse of specific medications such as gabapentin identified through claims-based algorithms.[38] Additionally, inappropriate procedures and care in acute settings were captured, including unnecessary surgical interventions or non-indicated trauma care among adult and pediatric hospital populations using registry and EHR data.[29,31] These examples demonstrate that LVC measures were applied across diverse healthcare settings, including primary care, inpatient trauma care, and system-level analyses as well as to a wide range of patient populations.

Components

Process measure components were defined across three key dimensions: the form of LVC addressed, the measure's purpose, and the monitoring goal. For example, measures targeted inappropriate services, such as blunt solid organ injury in low-risk populations,[29] transition in ICD-9 to ICD-10 to monitor Choosing Wisely adherence,[27] and medication-related LVC, national low-value prescribing practices.[30] Measures also varied in their purpose with some quantifying the prevalence of LVC,[25,26] preforming economic evaluation,[27,28] and identifying patient groups at risk of LVC exposure.[38] In line with this, the stated goals of measurement differed, including quantification, identification, claims-based algorithmic ratio measure creation, and, in one case, de-implementation[28] (Table 2). Together, these dimensions show that process measures are used for different but related aims, from describing the extent of LVC to supporting its detection and reduction.

Further components provided a systematic overview of how process measures are constructed and applied, highlighting variation across four key dimensions: measure concept, inclusion criteria, exclusion criteria, and measurement logic (Table 3). While sharing overlapping concepts (e.g., overuse, misuse, or adherence), measures differed substantially in how patient populations were defined through inclusion and exclusion criteria. For example, some measures focused narrowly on screening populations and excluded high-risk or symptomatic patients,[25,26,31] whereas others used broader indicators based on diagnostic coding.[32,33,35,36] Variation was also evident in the underlying measurement logic. Although ratio-based approaches were common, studies differed in how these were operationalized, including simple ratios,[25,26,37] multilevel indices,[35,36] or pattern-based thresholds.[34] Together, these differences illustrate that even when

Table 2. Classification of low-value care process measures by form, purpose, and goal.

Study	Form of low-value care	Purpose	Goal
Adams (2023)[25]	Screening overuse	Quantify	Quantification
Adams (2023)[26]	Screening overuse	Identify	Identification
Angiolillo (2019)[27]	Redundant services	Quantify	Algorithm development
Baek (2023)[28]	Repeat testing	Reduce	De-implementation
Boukar (2014)[29]	Inappropriate surgery	Identify	Algorithm development
Brett (2017)[30]	Low-value prescribing	Identify	Identification
Deshommes (2024)[31]	Pediatric trauma care	Quantify	Quantification
Fleming (2022)[32]	Screening and testing overuse	Identify	Algorithm development
House (2021)[33]	Overall pediatric LVC	Quantify	Algorithm development
Liu (2016)[34]	Polypharmacy	Identify	Algorithm development
Lowe (2014)[35]	Overuse and clinical waste	Quantify	Algorithm development
Segal (2015)[36]	Overuse composite	Quantify	Algorithm development
Soltana (2021)[37]	Inappropriate injury care	Identify	Algorithm development
Zhao (2022)[38]	Medication misuse	Identify	Algorithm development

Table 3. Components and operational definitions of process measures.

Study	Measure concept	Inclusion criteria	Exclusion criteria	Measurement logic
Adams (2023)[25]	Colonoscopy overuse	Screening patients	High-risk indication	Ratio
Adams (2023)[26]	Colonoscopy misuse	Screening cohort	Symptomatic patients	Ratio
Angiolillo (2019)[27]	Choosing Wisely adherence measure	Surgical admissions	ICD-9 to ICD-10 mismatch	Converted ratios
Baek (2023)[28]	Repeat HbA1c testing	All tests	Non-repeat	Test count within 60 days
Boukar (2014)[29]	ICD-11 based LVC algorithm	Stable blunt injury	Early mortality	ICD-11/AIS ratio
Brett (2017)[30]	Prescribing practices	Choosing Wisely criteria	Non–Choosing Wisely criteria	Multiple measures
Deshommes (2024)[31]	Pediatric trauma LVC	Trauma patients	Burn/poisoning	Incidence ratio
Fleming (2022)[32]	ICD-11 LVC measures	FFS beneficiaries	Outside CPC+ models	Ratio with exclusions
House (2021)[33]	Pediatric LVC calculator	ICD-defined cohort	Exclusions coded	Broad vs narrow ratio
Liu (2016)[34]	Polypharmacy pattern	≥2 prescriptions	Single drug	Refill frequency
Lowe (2014)[35]	Waste index	Indexed hospitals	Non-participating	Composite index
Segal (2015)[36]	Overuse index	Measurable procedures	Non-measurable care	Multilevel ratio
Soltana (2021)[37]	Injury care adherence	Registry admissions	Out-of-scope trauma	Ratio
Zhao (2022)[38]	Gabapentin misuse algorithm	≥1 prescription	Non-claims use	Pattern thresholds

Note. HbA1c = Hemoglobin A1c, AIS = Abbreviated Injury Scale, CPC+ = Comprehensive Primary Care Plus, ICD = International Classification of Diseases.

targeting similar aspects of LVC, process measures are constructed in diverse ways, reflecting differences in intended use cases, data sources, and clinical contexts.

Mapping of evidence

While several measures were designed to support system level monitoring or benchmarking, a limited number were embedded within de-implementation strategies, such as automated cancellation of unnecessary repeat testing[28] (Table 4). Evidence mapping revealed substantial heterogeneity in the data source, operationalization, and application of process measures across sources (Table 5). Measures primarily targeted overuse, adherence, and misuse, and were most often operationalized using ratio-based or index-based logic. Despite variation in measured concepts, a consistent methodological convergence regarding the reliance on administrative data sources and summary outputs (e.g., prevalence, scores, incidence ratios) were observed. Importantly, evidence mapping underscored pervasive data and measurement constraints across sources, including incomplete clinical detail,[37] reliance on proxies,[32] coding inaccuracy,[31] and complexity of measure construction.[36]

Table 4. Application of process measures to support de-implementation.

Study	De-implementation setting	Strategy	Outcome
Baek (2023)[28]	Yes	Auto-cancellation of unnecessary repeat tests	Reduced repeat testing
All others	No	Not reported	N/A

Table 5. Data sources and measurement approaches.

Study	Data source	Measure type	Measure output	Data limitations	Measurement limitations
Adams (2023)[25]	Insurance claims	Ratio	Relative change due to new ICD-11 coding	COVID-19 effects	Short time frame
Adams (2023b)[26]	Health registry	Ratio	Screening rate	Coding accuracy	Definition heterogeneity
Angiolillo (2019)[27]	EHR	Ratio	Choosing Wisely adherence	Single site	Conversion errors
Baek (2023)[28]	EHR	Algorithm	Retest prevalence reduction	COVID-19 effects	Downstream costs excluded
Boukar (2014)[29]	EHR	Algorithm	Proportion	Missing clinical detail	Algorithm lacks sensitivity
Brett (2017)[30]	Insurance claims	Catalogue	Prevalence	Protocol only	Not reported
Deshommes (2024)[31]	Health registry	Ratio	Incidence	Missing data	Coding reliance
Fleming (2022)[32]	Health registry	Ratio	Prevalence	Claims misclassification	Indication ambiguity
House (2021)[33]	Health registry	Calculator	Cost + count	Cost scope limits	Broad capture
Liu (2016)[34]	Insurance claims	Pattern	Polypharmacy	Pattern dependency	Limited drugs
Lowe (2014)[35]	Hospital database	Composite index	Cost + waste score	Inpatient only	Hospital manager comprehension
Segal (2015)[36]	Insurance claims	Index	Overuse score	Regional bias	Index complexity
Soltana (2021)[37]	Health registry	Ratio	Benchmarking	Proxy measures	Missing registry fields
Zhao (2022)[38]	Insurance claims	Algorithm	Misuse flags	Self-pay omission	Limited to expert specialties

Note. COVID-19 = Coronavirus Disease of 2019, EHR = electronic health record, ICD = International Classification of Disease.

Discussion

This review identified a relatively small body of 14 sources that reported on the development of process-based measures for the routine monitoring of LVC across various healthcare settings, mostly emerging after 2020. This late emergence is noteworthy, as concerns regarding unnecessary and ineffective care have been documented for decades; with the term "low-value care" appearing explicitly in peer-reviewed literature around 2010,[5] followed shortly thereafter by the emergence of Choosing Wisely.[16] Further, a majority of sources originated in countries with more mature Choosing Wisely initiatives (i.e., The United States and Canada), indicating temporal growth in the development and uptake of structured approaches to identifying and monitoring LVC.

However, despite the growing interest in the monitoring and subsequent de-implementation of LVC, the limited volume and heterogeneity of evidence from this review suggests that routine LVC measurement remains underdeveloped for consistent application within systemwide monitoring efforts. Tables 2–5 collectively illustrate that existing routine measurement structures are predominantly focused on identification and quantification, with limited representation of de-implementation activities alongside the presentation of process measure construction.[28]

Together, these initial findings may suggest that while interest in routine LVC monitoring is increasing, its application may be fragmented and insufficiently linked to practice change. This pattern may highlight an important disconnect between the recognition of LVC as a health system priority and the availability of LVC measurements structures to support sustained practice change through routine monitoring efforts. Alternatively, this may reflect a continuing trend of measurement structures being described outside of de-implementation literature.[10,17]

Across the included sources, process measures were operationalized mostly within site specific and regional administrative claims or electronic health records, drawing on criteria derived from international initiatives such as Choosing Wisely and standardized ICD-10 and ICD-11 coding structures. While global Choosing Wisely initiatives have been instrumental in advancing consensus around what constitutes LVC,[7,14] findings from this review indicate substantial variation in how process measures are defined and interpreted in practice. Many sources relied on ratio-based approaches that were feasible within existing data infrastructures but that were also limited by proxy measures, coding dependence, and incomplete clinical detail. As a result, measures were often well suited to continually estimating LVC prevalence but were less capable of informing actionable care pathway level interventions.

This lack of cohesive direction is further reflected in the study selection process. Although approximately 900 sources advanced to full-text review, more than 600 in total were excluded because they did not explicitly report the structure of the process measures used, the methods for routine assessment, nor clear operational definitions of LVC, even when successful implementation of routine LVC monitoring was claimed. This limited disclosure of routine LVC measurement methods may constrain cumulative advancements in this field, further hampering efforts to translate conceptually aligned approaches into scalable monitoring systems. Without clearer articulation of measurement logic and operational assumptions successful implementation of monitoring systems may remain difficult to reproduce, benchmark, or adapt at scale. An opportunity to standardize and strengthen the reporting of routine LVC monitoring may therefore lie within established monitoring structures, such as those proposed by the OECD HCQI Framework,[9] which provides a system-level structure for applying shared measures more consistently across health settings.

However, considering the above, these heterogeneous applications of monitoring from a shared conceptual foundation may reflect purposeful adaptation to diverse data infrastructures and healthcare settings, thereby supporting the potential of future flexibility and applicability across different healthcare monitoring domains. Nonetheless, further work is needed to translate the conceptual alignment of what constitutes LVC into more cohesive and operationally consistent measurement structures that support shared directions in scalability. This current discordance may provide clear opportunities for routine process measurement to expand amongst national and international partners, through a shared conceptual underpinning while preserving contextual adaptability.

Considering these potential future applications, it is important to note that data and measurement limitations were pervasive across sources and frequently constrained the interpretability and usability of process measures. Common challenges included restricted data scope, definitional heterogeneity, and complex index construction, all of which pose barriers to comparability and routine implementation, even if supported by internationally adopted AIS, ICD-10, and ICD-11 coding structures. These limitations may partly explain why most identified measures were primarily used for algorithm or index construction rather than within real-time quality improvement or de-implementation initiatives through accessible methods, such as strategic data dashboards. Addressing these issues will likely require greater emphasis on measurement transparency, standardized nomenclature, and alignment with clinical workflows and behavioural mechanisms of care delivery across similar health systems.

Taken together, these findings suggest that while process-based measures hold considerable promise for routine monitoring and ultimately reducing LVC; stronger links between measurement development and de-implementation are needed. Future work should prioritize the design of process measures that are not only methodologically robust, but that are also explicitly intended for use in de-implementation strategies, with attention to organizational context, data feasibility, and end-user needs. Building on this foundation, there are clear opportunities to expand routine LVC process measurement at both national and cross-national levels, across similar and dissimilar healthcare systems, and to explore areas for result dissemination amongst care providers (i.e., via strategic dashboards).

Progress in these areas requires clearer articulation of measurement logic aligned with reporting standards that support transparent interpretation, adaptation, and replicability. Enabling clear interpretation of routine measurement structures could be leveraged to assess the real-world impact of Choosing Wisely recommendations, strengthening alignment between LVC measurement and Choosing Wisely definitions of LVC. Such feedback loops may also inform the development of new LVC recommendations and support subsequent de-implementation strategies through closer clinical and patient partnerships. Without these advances, the potential for routine measurement to drive sustained reductions in low-value practices may remain unrealized.

Limitations

This scoping review is subject to several methodological limitations. In line with JBI and PRISMA-ScR guidance, no formal assessment of study quality or risk of bias was undertaken, which may limit interpretation of whether observed patterns reflect well-validated measurement approaches or artefacts of underlying data and design limitations. The review

is also limited by reliance on the reporting quality of included sources, which was frequently heterogeneous due to a high variety of LVC foci. Further, because this review focused on mapping existing measures rather than evaluating their performance, conclusions should be interpreted as descriptive of methodological approaches currently in use rather than indicative of best or preferred measurement practice. Finally, the use of routine process measures to support de-implementation may be underrepresented in this review, as such initiatives are not always reported alongside detailed measurement structures. As a result, the alignment between routine measurement and de-implementation efforts may be greater in practice.

Conclusion

Existing evidence demonstrates strong conceptual alignment in definitions of LVC, largely informed by initiatives such as Choosing Wisely, alongside growing recent interest in the development of routine process-based measures. This shared conceptual foundation, combined with the adaptability of measures across diverse data infrastructures, highlights important opportunities for applying LVC monitoring across healthcare settings.

However, substantial variation currently exists in how these concepts are operationalized into scalable, comparable, and practical routine measurement structures. Despite growing recognition of LVC as a major health system challenge, the reporting of routine process-based measurements alongside system level monitoring and de-implementation remains limited. This may reflect both a gap in how measures are designed for practice change and a separation in how measurement and de-implementation activities are reported in the literature.

Advancing routine LVC monitoring will require clearer articulation of measurement logic, improved transparency in reporting, and the development of end-user-oriented tools that translate data into actionable insights to actively support de-implementation. Aligning these efforts with established system-level frameworks may further enable national and cross-national monitoring, allowing routine process measurement to more effectively contribute to meaningful and sustained reductions in low-value practices.

Ethics and consent

Ethical approval and consent were not required.

Data availability

All extended data supporting this study have been deposited in the Open Science Framework repository. The dataset, titled "Extended Data for: Process Measures Developed for the Routine Monitoring of Low-value Care with Electronic Health Data: A Scoping Review," is available at Open Science Framework (https://doi.org/10.17605/OSF.IO/Y7FR4).[39] The repository includes the Population–Concept–Context framework used to define the research question, the full search strategy, and the data extraction instrument.

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?

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Introduction

There are some points that could help to improve the introduction.

First, I have some issues with the definition of low-value-care (LVC). Choosing the EU expert panel definition means also including underuse and misuse. This is a broad definition, which is problematic given the aim and methods of this study. There are many other definitions of LVC that might be more suitable.
More importantly, the patient perspective is totally missing in this definition. One of the most outstanding problems of LVC is the gap between the care delivered and the care that patients want. See [Ref 1]
Finally, a more modern definition of LVC would also include its impact on sustainability and on the use of a scarce workforce.

Second, there should be a bridge mentioning the connection between Value Based HealthCare (VBHC) and reducing LVC. The worlds of VBHC and LVC are not connected. A suggestion is mentioning that VBHC is focused on increasing high-value care and de-implementation is focused on decreasing LVC.

If you mention “To date, health systems and international bodies have undertaken efforts to monitor and minimize the impact of LVC”, I expect more recent references; the current ones are more than 10 years old.

Your assumption “In the context of LVC monitoring, process measures have been identified as particularly relevant as they directly track care provided and can be observed consistently across multiple health service settings.” is debatable. When we really want to know whether there is value added to the patient, we need to be focused on outcome measures, one of the most important aims of VBHC. These are the ones that will change medical practice. That was also one of my conclusions of the Choosing Wisely International Roundtable in Stockholm in October 2026.

I would expect a sounder argument for this choice which is crucial for the added value of this paper.

Methods
It is peculiar to start the methods with an (outdated, the website of the ABIM has not been updated in a long time) definition of LVC that doesn't correspond with the definition of LVC with which the paper started.

I would like to see the search strategies. I am very interested in the formulations, considering the issues in defining LVC.
Moreover, the search was performed a year ago, and the field has developed rapidly since 2020. I would suggest updating the search to cover the past year to get an up-to-date overview.

You also included protocols. In most reviews, they are excluded. What was your rationale for including those?

"a limited number were embedded within de-implementation strategies, such as automated cancellation of unnecessary repeat testing". I think you mean: "Only one...
Doesn't this finding underline the fact that process measures are less supportive of de-implementation strategies than outcome measures?

Discussion
Instead of referring to the outdated website of the ABIM, I would suggest referring to more recent papers about the Choosing Wisely Campaign such as [Ref 2]

"Further, a majority of sources originated in countries with more mature Choosing Wisely initiatives (i.e., The United States and Canada)," This is incorrect. The US campaign has had little impact and soon faded out. In my opinion it is remarkable that no study originated in Europe while some European Choosing Wisely campaigns flourish (Norway, Sweden, Italy, Catalonia) and there are some hotspots of de-implementation research (the Netherlands and Sweden). Apparently, they are less interested in this kind of research. Personally, I think an important reason is the lack of a sound data infrastructure in many European countries combined with far-reaching privacy regulation that impedes using data for routine monitoring.

Another important restriction of this study is only including documents in the English language. Many non-English-speaking countries will publish those results nationally in grey literature and in their own language. In my own country, the Netherlands. there is sophisticated system of routine monitoring of LVC process measures. This is only described on the website of our national programme *Healthcare evaluation and appropriate care*. It is based on routine hospital data in a national database with definitions agreed on by all parties (healthcare professionals, healthcare insurers and healthcare data specialists). See
https://zorgevaluatiegepastgebruik.nl/onderwerpen/onze-werkwijze/implementeren-en-monitoren/spiegelinformatie-en-udds (in Dutch)
You won't catch these developments with the described method.

"Taken together, these findings suggest that while process-based measures hold considerable

promise for routine monitoring and ultimately reducing LVC". Again, measuring outcomes is in my opinion much more important for monitoring the impact of de-implementation strategies. If we really want to mean something for patients and conclude that the added value for patients is increased, we should focus on oiutcomes.

'Enabling clear interpretation of routine measurement structures could be leveraged to assess the real-world impact of Choosing Wisely recommendations,' These recommendations alone will not change medical practice. A tailored de-implementation strategy based on identified barriers and facilitators will.

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Are the rationale for, and objectives of, the Systematic Review clearly stated?

Partly

Are sufficient details of the methods and analysis provided to allow replication by others?

Partly

Is the statistical analysis and its interpretation appropriate?

Not applicable

Are the conclusions drawn adequately supported by the results presented in the review?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: De-implementation of low-value care

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.