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Detecting Fragmented Clinical Pathways: A Scoping Review Based on Process Mining Approaches

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Systematic Review

Keywords: Process Mining, Workflow, Delivery of Health Care, Integrated, Continuity of Patient Care, Health Care, Care Fragmentation

Posted Date: June 18th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9636654/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Mapping the care journey has been recognized as a fundamental strategy for improving the quality and excellence of health services. Analyzing the care pathway allows for the identification of needs, opportunities for improvement, and organizational functioning patterns, contributing to greater personalization and efficiency of care. Health systems remain largely structured around clinical guidelines or specific care pathways. The inherent complexity and variability of healthcare processes contribute to discontinuities, informational gaps, and organizational inefficiencies. Process mining has shown relevant potential in the analysis of care trajectories; however, its application has been predominantly concentrated in hospital settings and in specific pathologies. Understanding how such fragmentation manifests is essential to improve care models and mitigate gaps in service delivery. This study aims to investigate and systematize elements that characterize the fragmented care journey in order to support future analytical modeling and structured interventions based on process mining.

Methods

A scoping review was conducted following the Population–Concept–Context (PCC) framework and PRISMA-ScR guidelines, with the protocol registered in the Open Science Framework (identifier: 10.17605/OSF.IO/HG42U). Searches were carried out in PubMed, Scopus, Web of Science, Cochrane, and LILACS, including studies published between 2000 and 2025 in English. Study selection was performed by two independent reviewers, with additional articles identified through citation tracking. A total of 39 studies comprised the final sample. Data were systematically extracted and synthesized through descriptive and narrative analysis.

Results

Although care fragmentation is widely recognized as a structural challenge within health systems, no literature was identified that conceptually delineates the term "fragmented care journey." The characteristics associated with the phenomenon were organized into four domains: Care Pathway, Health Information Systematization, Temporality, and Health Governance. Process mining emerged as a relevant methodological tool for identifying care patterns and was more frequently reported in hospital settings.

Conclusions

The findings of this review indicate that the fragmented care journey remains a conceptual gap, permeated by multifactorial phenomena, clinical and operational variability, and systemic limitations in

information integration. Process mining demonstrates promising potential for mapping such variations. This study is expected to contribute to the conceptual refinement of the term "fragmented care journey" and to the development of integrated, patient-centered strategies.

Background

Mapping the patient care journey in health settings is a well-established approach for understanding user experiences throughout their interactions with health services and constitutes an essential tool for improving the overall experience of care recipients. This knowledge enables the delivery of more personalized care, generating competitive advantages and greater satisfaction among patients [1, 2]. Understanding each step a patient traverses throughout the care process and how they interact with services at each stage are key aspects for identifying needs, opportunities for improvement, and, consequently, for delivering excellence in health services [1, 2].

Over the years, researchers have extensively studied the incorporation of artificial intelligence (AI) in healthcare, including prediction of clinical outcomes and improvement of clinical decision support systems. However, AI applications in health extend well beyond these domains [3]. It is now possible to enhance patient-centeredness in care delivery through self-management tools such as mobile applications, assistive robots, and self-monitoring devices, all of which are key components of Human-Computer Interaction (HCI) technologies in health [4].

Healthcare processes are frequently challenging due to their complexity, dynamic nature, and the multiplicity of knowledge required. Identifying typical and atypical patient journeys and monitoring compliance with established policies and standards have thus become central concerns [1]. Different clinical specialties are often simultaneously involved in the care of a single patient. For instance, a patient diagnosed with cancer may receive care from a medical specialty, a surgical specialty, and clinical oncology, each contributing a unique set of knowledge and expertise [5].

Ciapponi et al. [6] note that care delivery arrangements are influenced by factors such as who receives care and when, who provides it, the working conditions of care providers, coordination among different providers, the physical location where care is delivered, the use of information and communication technologies, and quality and safety systems. The manner in which services are delivered can have direct implications for the effectiveness, efficiency, and equity of health systems.

Healthcare systems remain largely structured around a disease-centered paradigm, which is directly associated with several challenges observed in routine practice. Boeykens et al. [7] argue that care organization is predominantly driven by disease-specific clinical guidelines, which may be effective for patients with a single condition but proves insufficient when addressing the complexity of individuals with multiple health problems or chronic conditions. Patients with multimorbidity often face several parallel care processes for different conditions, creating a considerable risk of fragmented care, a risk that intensifies when health professionals maintain a primary focus on the isolated management of each disease, overlooking the integrated perspective of the patient.

Healthcare processes are partly complex because they tend to exhibit significant variability. Patients require different types of treatment depending on their specific characteristics, responses to treatment, and other contextual factors, meaning that care processes must continually adapt to the particular environment of each situation [8]. Within systematic process management, which encompasses components of business process management, several reliable methods exist, including process modeling, process analysis, and process redesign [9].

Given the plurality of settings in which care delivery takes place and the need to understand organizational functioning in health services, Process Mining (PM) can provide operational support by detecting problematic cases in execution, predicting their trajectory, and suggesting recommended actions [10, 11]. PM enables the objective reconstruction of the care journey from real-world records, allowing the identification of discontinuities, loops, delays, and unanticipated transitions between services [8]. Unlike approaches based on prescribed clinical pathways, PM allows analysis of the trajectories actually followed by patients, enabling the identification of care fragmentation across multiple dimensions, including temporal, informational, and organizational.

The application of PM in healthcare is often restricted to specific contexts, individual pathologies, or single institutions. A systematic review found that 36% of PM studies in healthcare were conducted in hospital settings, a circumstance that does not allow for a comprehensive view of care processes across the full trajectory of a patient's journey [12]. Accordingly, most studies remain confined to care trajectories that have been clearly delineated prior to the application of PM techniques.

Given this identified gap, namely patients who lack predefined care pathways through established care lines, there exists a risk of care discontinuity. Considering that PM has yielded promising results in the analysis of care journeys, it may serve as a valuable tool for identifying care disruptions. This study therefore holds academic relevance, both by contributing to the conceptual delineation of the fragmented care journey and by strengthening the application of computational methods in healthcare research.

Drawing from the need to understand the components of a fragmented care journey and how PM might support this characterization, the research questions guiding this study are: What elements characterize a fragmented care journey? Can process mining support its identification?

The objective of this article is to identify concepts and/or patterns that allow for the characterization of fragmented journeys in outpatient care settings, so that these may subsequently inform modeling and analysis through process mining in future studies.

Methods

A scoping review was conducted to explore concepts, patterns, gaps, and/or characteristics that identify fragmented outpatient care journeys. The protocol was registered in the Open Science Framework on September 21, 2025, under the identifier 10.17605/OSF.IO/HG42U.

Scoping reviews are an effective and useful approach for synthesizing concepts and emerging topics within a specific domain. This review was reported in accordance with the PRISMA-ScR guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) [13].

The research question was formulated using the Population, Concept, and Context (PCC) framework, as recommended by the Joanna Briggs Institute [14]. In this context, the population refers to users receiving care within outpatient service flows throughout their care journey. The concept encompasses fragmentation or disruption of that journey, with the aim of identifying factors that may disarticulate care across different points of care delivery. The context corresponds to the use of process mining tools as a methodological approach for mapping and/or understanding the characteristics of such fragmentation.

Inclusion criteria

Eligibility criteria were defined to ensure methodological rigor and alignment with the review's scope. Studies published between 2000 and 2025 were considered, provided they were available in full text and written in English. Only research and review articles were included. Thematic relevance was assessed through the reading of titles and abstracts, allowing the identification of studies that effectively met the proposed objective and the established thematic scope.

The temporal range was defined based on the first publications to employ the Process Mining technique [10].

Searches were conducted between August and September 2025, using institutional access from Pontifícia Universidade Católica do Paraná, through the Portal de Periódicos CAPES, with authentication via the Comunidade Acadêmica Federada (CAFe).

Search strategy

An initial bibliographic review was conducted to identify keywords allowing for the most effective search strategy on the topic under study. Keywords were discussed among the research team and selected according to Medical Subject Headings (MeSH) terms, which are organized in a hierarchical structure, commonly referred to as a MeSH tree, branching from general to more specific terms [15]. Boolean operators (AND and OR) were applied to combine the selected MeSH terms and to retrieve all relevant studies meeting the scope and inclusion criteria. The terms "process mining" and "mining process" were also included given their centrality to the study scope. Studies on care journeys using data mining approaches were not included.

The terms were initially tested in PubMed and subsequently applied to four additional databases: LILACS, Cochrane, Web of Science, and Scopus. Selected terms were organized and grouped according to three categories: tools, health area, and analysis, as illustrated in Table 3.

Table 3 Grouping of terms for the scoping review

Tool		Health Area		Analysis
mining process[1]	**AND**	Healthcare	**AND**	Delivery of Health Care, Integrated
OR		**OR**		**OR**
process mining[1]		Health Care		Patient-Centered Care
OR		**OR**		**OR**
workflow		Access to Primary Care		Intersectoral Collaboration
				OR
				Continuity of Patient Care
				OR
				Patient Care Planning
				OR
				Critical Pathways
				OR
				Health Status

[1] Van der Aalst (2004). All other terms are MeSH descriptors in Health Sciences.

[1] Van der Aalst (2004). All other terms are MeSH descriptors in Health Sciences. Source: The authors, 2026.

Combining the terms from Table 3, the search string is as follows: ((("Delivery of Health Care, Integrated") OR ("Patient-Centered Care") OR ("Intersectoral Collaboration") OR ("Continuity of Patient Care") OR ("Patient Care Planning") OR ("Critical Pathways") OR ("Health Status")) AND (("mining process") OR ("process mining") OR ("workflow")) AND (("Healthcare") OR ("Health care") OR ("Access to Primary Care"))).

The researchers involved in this study are affiliated with graduate programs (stricto sensu), with academic backgrounds focused on the applicability of process mining, under the supervision of their respective academic advisors. Prior to the screening stage, the reviewers participated in a conceptual alignment meeting, during which operational definitions and examples related to the fragmentation of care journeys were discussed, including direct delineation of the concept of the care journey, characteristics of processes, and scenarios not delineated within established care pathways. This procedure aimed to standardize the understanding of eligibility criteria and reduce interpretive inconsistencies during the reading of titles, abstracts, and full texts.

Initial assessment and selection of scientific documents identified across databases were conducted independently by two reviewers, with duplicate articles duly excluded. The preliminary analysis involved the reading of titles and abstracts to verify thematic adequacy and study type, with divergences resolved by consensus during reviewer meetings.

In the subsequent stage, eligibility was confirmed through full-text reading. Complementarily, the reference lists of selected studies were examined to identify potentially relevant additional work. The entire selection process was recorded in a spreadsheet and represented in a flowchart developed in accordance with the methodological guidelines of PRISMA-ScR, as described in Fig. 1.

[Figure 1 near here]

Fig. 1 PRISMA-ScR flowchart. PRISMA-ScR: Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews. Source: The authors, 2026.

In addition to the 32 articles selected through the described strategy, the reference lists of those articles were examined, resulting in the inclusion of seven additional studies through citation tracking. These studies met the inclusion criteria and were considered relevant to the research, bringing the total final sample to 39 studies.

Following the selection phase, systematic data extraction was conducted using a standardized spreadsheet developed by the research team. As each text was read, the authors' observations and perceptions were grouped to map the following research questions: (1) Is there a conceptual definition of Fragmented Care Journey? (2) What described characteristics relate to the concept of Fragmented Care Journey? (3) Was process mining applied in the study? (4) In which healthcare setting was the study conducted (outpatient or inpatient)?

After tabulating the information extracted from the articles, common features present across each study were identified and categorized into four domains addressing the elements that characterize care journey fragmentation.

Data extraction was conducted in a descriptive and interpretive manner, allowing for the mapping of available evidence and the narrative synthesis of characteristics of the fragmented care journey in outpatient settings within the context of process mining.

The results analysis phase was conducted with the participation of academic advisors, whose contribution enabled methodological validation and critical appraisal of the findings. This was essential for ensuring the scientific rigor of the study, guaranteeing consistency in the data collection, extraction, and synthesis processes, as well as the adequacy of interpretations to the scope and objectives established for the review.

Based on the results analysis, a conceptual framework was developed to facilitate interpretation of the dimensions related to care journey fragmentation.

Results

This study presents the elements that compose care journey fragmentation, describes the main forms and healthcare settings in which process mining has been applied for understanding care journeys, and proposes a conceptual framework to facilitate comprehension of these elements.

Among the analyzed articles, no explicit citations were identified that define the fragmented care journey. This absence reinforces the need to establish criteria supporting its delineation, thereby enabling greater clarity in identifying the phenomenon in outpatient settings. The main findings of the included studies are summarized in Appendix 1.

The World Health Organization [16] delimits traditionally employed concepts such as access, availability, utilization, and coverage, which are frequently used to indicate the extent to which the population receives needed services. Access, of a multidimensional nature, requires systematic assessment of the physical, economic, and socio-psychological conditions influencing people's capacity to use services. Availability, as a component of comprehensiveness, refers to the physical existence of a minimum service offering. Utilization corresponds to the volume of services effectively consumed, while coverage expresses the proportion of individuals who receive a specific intervention among those who need it.

In that same document, the WHO recommends monitoring the indicator: "1c: Number of outpatient visits per 10,000 inhabitants per year," which uses as its numerator the number of visits to health facilities for outpatient care, excluding immunizations. Analysis of this indicator is carried out through comparative results among participating WHO countries.

In Brazil, the Ministry of Health, through Ordinance No. 1,101/2002 [17], established a parameter of 2 to 3 physician consultations per inhabitant per year. This ordinance was later revoked in 2015 by Ordinance 1,631 [18], which established the ratio of the number of inhabitants per physician.

Although these indicators provide information on population accessibility to health services, they remain insufficient for analyzing the phenomenon of the fragmented care journey. Gaps persist related to the practices of healthcare providers and to patients' health literacy levels, aspects that require specific and in-depth assessments for a more comprehensive understanding of the scenario.

Elements related to the fragmented care journey

The elements characterizing care journey fragmentation are presented in Table 2. These elements were grouped according to their conceptual proximity and relevance to understanding the subject, into four main categories: Care Pathway, Health Information Systematization, Temporality, and Health Governance. A description of each category follows.

Table 2 Elements of the Fragmented Care Journey

Element	Key Characteristics	Reference
Care Pathway	Patient-centered approach in trajectory analysis	[19, 20, 21]
	Clinical pathway as a normative route	[22]
	Disease-centered paradigm and its limitations in multimorbidity	[7]
	Interdependent clinical networks and decision complexity	[23]
	Interprofessional collaboration and holistic approach	[24]
	Case management	[25]
Health Information Systematization	Care transfer across contexts	[26]
	Consumer health technologies	[4]
	Need for coordination in complex patients	[27]
	Electronic health record integration and longitudinal care view	[19]
	Benefits of electronic medical records	[28]
	Information fragmentation from non-integrated systems	[29, 30]
	Silo structures	[27, 31]
Temporality	Prolonged diagnostic pathways	[32]
	Temporal dispersion of interventions	[33]
	Waiting times	[19]
	Time spent on record-keeping and clinical documentation	[22]
	Spatiotemporal distribution of the care journey	[34]
	Prediction of critical events	[35]
Health Governance	Coordination of specialized workforce	[36]
	Risk, cost, and quality management	[37]
	Variations in integrated care models	[38]
	Decentralized governance and systemic fragmentation	[39]

Source: The authors, 2026.

Care Pathway

Analyzing the patient's trajectory throughout the care process allows for an understanding of how users experience care, thereby configuring a naturally patient-centered approach [19]. In this sense, the clinical care pathway represents the "ideal" or formal route of the patient, constituting a normative construct that seeks to guide the care journey so as to promote best practices, procedural consistency, and an optimized patient flow throughout the care process. However, if the care pathway does not account for the clinical history and individual circumstances of each patient, effectively personalizing care becomes unfeasible [22].

At the same time, health systems remain predominantly guided by a disease-centered paradigm, to which many of the challenges currently observed in practice are linked. In this model, care organization is largely driven by disease-specific guidelines, which may be effective for patients with a single condition but proves insufficient when confronted with the complexity of individuals with multiple health problems [7].

As protocols are increasingly tailored to individual patients and new therapeutic variations and alternatives are introduced, clinical pathways begin to form interdependent networks, making the decision-making process progressively more complex [23].

Thus, the patient-centered approach to the care pathway is grounded in the identification of contextual factors that influence care continuity among the different professionals involved in patient care. This continuity underpins a comprehensive and coordinated practice, structured from a "day-in-the-life" perspective, providing a succession of articulated and uninterrupted events aligned with the patient's healthcare needs [20].

Complementarily, the perspective of family medicine encompasses the diagnosis and treatment of a wide variety of health conditions, requiring professionals to understand the biological, psychological, and social aspects influencing the patient, thereby contributing to integrative approaches. For this holistic approach to be effective, interprofessional collaboration among physicians, nurses, pharmacists, and rehabilitation specialists is essential to ensure coordinated, person-centered care [24].

More recently, advances have been made toward patient-centered clinical decision support, which incorporates evidence from patient-centered research, patient-reported data, individual preferences, social determinants of health, and digital tools, facilitating shared decision-making [21].

Despite the various barriers related to health systems, patients, and care providers that hinder the translation of science into care practices, consistent evidence suggests that strategies such as patient education and empowerment, collaborative care, and case management are effective in reducing clinical inertia and improving treatment adherence, thereby promoting better clinical outcomes [25].

It is therefore necessary to emphasize that the lack of health information interoperability contributes to care journey fragmentation and hinders care delivered by interdisciplinary health teams.

Understanding the care pathway beyond the disease-centered paradigm, combined with interprofessional integration, constitutes a fundamental element for mitigating care journey fragmentation and promoting the personalization of healthcare.

Health Information Systematization

Primary care is structurally less complex than hospital care, given that patients do not remain physically present throughout the entire care pathway. Furthermore, care is often transferred among different contexts and service providers, requiring patients to take greater responsibility for self-management and the treatment of their own health conditions [26].

As healthcare expands into more community-based and public settings, aiming to promote preventive and patient-centered practices, individuals are increasingly involved in managing their own self-care, driven by the use of various consumer health technologies [4].

Individuals with complex and long-term needs require coordinated, integrated care involving multiple service providers. However, while other sectors have already incorporated digital solutions to integrate fragmented processes and improve service efficiency and quality, the healthcare sector has made slower progress in this domain [27].

Coordinating care plans among different providers facilitates integrated health service delivery [7]. Integrating information into electronic health records allows healthcare professionals to obtain a comprehensive view of previously followed trajectories and associated waiting times, providing relevant insights both for understanding individual patient needs and for assessing service quality [19].

Electronic medical records have attracted increasing attention due to the benefits they can offer to health systems, including improved organization of clinical patient information, enhanced care coordination, and facilitated electronic access to medical data, complementary information, and specialist reports [28].

Conversely, the existence of separate electronic record systems or restrictions on access to the patient's complete record generate significant disruptions in clinical workflow, as health professionals must seek information from multiple sources or, in some cases, fail to fully comprehend the scope of care provided [29].

Health Information Exchange (HIE) mechanisms enable the automated sharing of data among different healthcare organizations. Despite numerous HIE systems having been developed over the past two decades, many have faced difficulties in consolidating, largely due to technological and organizational limitations [31].

Current health information and communication technology infrastructures tend to replicate and reinforce the silo structures of service provider organizations. This configuration intensifies organizational

fragmentation and undermines the fluidity of information exchange. As a result, the costs and quality of care for people with complex, long-term needs are negatively affected by interruptions, gaps, and duplications in service delivery [27].

As a consequence of this structural and technological gap, the lack of integration across the multidisciplinary service network can result in care fragmentation and poor health outcomes [30].

Understanding the interfaces among primary care, self-care, technological resources, and information integration is essential for addressing existing structural barriers and, in turn, reducing care fragmentation, promoting a more continuous, traceable care pathway oriented toward patients' actual needs.

Temporality

The prolonged duration of diagnostic pathways not only compromises therapeutic efficacy but also leads to increased healthcare costs and the aggravation of patient suffering [32].

In this regard, different temporal dispersions of the same set of clinical behaviors may indicate, for example, that the same therapeutic interventions are being carried out in distinct care contexts [33].

The identification of secondary waiting times throughout the care process constitutes an essential first step toward investigating the relationship between waiting durations and patient engagement outcomes [19]. The time devoted to interacting with electronic health records and consulting clinical guidelines inevitably reduces direct and meaningful contact with the patient [22].

The patient journey corresponds to the spatiotemporal distribution of interactions established between the patient and the various care environments throughout the care process [34]. The prediction of critical events, such as waiting times and workload peaks, allows for more efficient resource management and anticipatory workforce allocation, contributing to the improvement of care performance [35].

Based on the foregoing, it is evident that within the care journey, the management of the temporal dimension can be perceived as a component of significant impact on care continuity.

Health Governance

The integration of healthcare is an international priority. However, for this goal to be effectively achieved, managers must efficiently coordinate care across an increasingly specialized and interdependent health workforce [36].

In this context, the quality of patient care is intrinsically linked to effective management of healthcare expenditures, risk, and quality. This optimization constitutes a decisive factor for the success and sustainability of organizations [37].

Furthermore, integrated care models present variations across several dimensions, including, but not limited to, the composition and dynamics of care teams, the spatial organization of services, forms of interprofessional collaboration, and protocols for detecting, treating, and monitoring patients [38].

Decentralized governance models can also be observed, as in Switzerland, where reaching consensus on health system governance constitutes a significant challenge given the country's highly fragmented model, characterized by the strong independence of its actors and the coexistence of public and private sectors. An illustrative example is the requirement for the population to purchase health insurance plans offered by over forty private, non-profit companies, most of which are poorly regulated. In such a context, establishing broad consensus for implementing a national health monitoring system becomes practically unfeasible [39].

Thus, it becomes evident that care integration depends not only on clinical and organizational guidelines but also on political-administrative structures capable of fostering governance, inter-institutional coordination, and shared care visions.

Application of process mining in understanding care journeys

Among the studies evaluated in this review, 41% employed process mining techniques in their investigations, demonstrating the consolidation of this method as a structuring tool for understanding care patterns, operational deviations, and behavioral variations across care trajectories.

Considering the fragmentation dimensions identified in this review, namely Care Pathway, Health Information Systematization, Temporality, and Health Governance, PM presents potential for supporting the analytical identification of these phenomena. The Care Pathway dimension can be investigated through process discovery and variant analysis techniques, allowing the identification of real trajectories and deviations among different care routes. The Temporality dimension can be analyzed through performance metrics and temporal analysis, enabling the identification of waiting times, delays, and gaps between events. Health Information Systematization can be explored by integrating multiple event logs and analyzing interactions among different services, while the Health Governance dimension can be assessed through conformance checking techniques, allowing the identification of deviations from expected care flows.

PM is a research discipline focused on providing evidence-based analysis for the effective management of business processes [40]. Drawing from process execution data and leveraging its analytical logic and automated reasoning capabilities, PM ensures the integrity, objectivity, and universality of identified patterns, conferring greater rigor and consistency to the analysis of care flows [33].

A significant limitation of current PM methodologies is that, while they enable the generation of qualitative evidence and consistent graphical representations of how work is performed, they do not

offer adequate mechanisms for quantifying variation across different trajectories [41].

PM techniques can be employed both to verify compliance with clinical guidelines and protocols and to evaluate the performance of health services. Although PM has been applied with increasing frequency in healthcare, particularly in initiatives related to disease trajectory modeling and clinical pathway analysis, the literature suggests that its adoption within healthcare organizations remains limited, largely confined to specific case studies developed in research settings [19]. The unsupervised machine learning approaches most commonly used in clinical pathway discovery include PM, sequence mining, and clustering methods, which are often applied in combination [42].

In this context, PM techniques can identify real behaviors and hidden patterns from event logs and, when applied to clinical settings, allow the recognition of critical treatment topics and their transitions across patient trajectories without subjective biases [40]. PM also contributes to health economic analyses by producing individual cost estimates and visual representations of care variations, using data extracted from electronic records such as consultations, procedures, and prescriptions to derive process models and map actual patient trajectories [23].

In healthcare, clinical pathway analysis consists of the process of generating knowledge about how care activities influence patients' care journeys. The knowledge obtained through this analysis can be applied to various purposes, including the (re)design and optimization of clinical pathways, clinical decision support, detection of medical deviations, and organizational process management in health [33].

In the context of health services and public policy research, PM can be used to capture and represent models of clinical processes from records available in information systems [43]. Moreover, by employing large volumes of hospital data, PM allows the modeling of patient journeys, monitoring of compliance with care guidelines and standards, identification of deviations, and the generation of recommendations aimed at continuous quality improvement [44].

Given the high variability and uncertainty in patient flows, the automatic identification of clinical pathways constitutes a central challenge for advancing the personalization of care [45]. Understanding the actual characteristics of care flows is thus fundamental, as professional variability and logistical limitations may compromise protocol execution and demand adjustments capable of improving the effectiveness of interventions [46]. It is important to emphasize that the process map is delineated in the context of the patient journey, considering the interactions established with the health professionals responsible for delivering care and the services rendered [47].

The primary motivation for extracting clinical pathways lies in knowledge discovery, through the application of machine learning methods aimed at identifying care patterns in specific patient groups or healthcare institutions [42]. From the patterns and process paths identified, novel and relevant knowledge about process functioning can be extracted, which may support the user in making appropriate decisions [33].

The configurations of care pathways tend to present high complexity, as they are frequently used in health services both for patient management and for reporting purposes. Furthermore, the configuration and the data collected may change over time, contributing to a high degree of variation in basic event logs [19].

Spaghetti workflow models are highly complex and difficult to interpret, as diversity is an inherent characteristic of most health data. More recently, within the scope of PM, sequence mining algorithms have been proposed for identifying patterns in clinical trajectories. Unlike traditional approaches, these algorithms do not seek to reconstruct the patient's complete trajectory from start to finish, but rather to detect recurrent patterns, including temporal variations between events [48].

Intensive treatment pathways, characteristic of secondary and tertiary care and of specialized primary care centers such as oncology, have clearly defined boundaries and complete records of care interactions. This structure facilitates the application of PM, as it enables full tracking of patient trajectories and the use of consistent datasets [26].

Most medical conditions lack clearly established institutional guidelines. In this context, PM proves a valuable tool for generating initial insights into variability in patient management, enabling the identification of delays and bottlenecks and supporting the coordination of care, orders, and resources in a more efficient manner [41]. Clinical decision support systems have demonstrated improvements in patient-centered outcomes, including the reduction of conflicts during decision-making processes [49].

PM therefore proves to be not merely a technical analytical tool but a strategic resource for understanding, improving, and personalizing care flows, contributing to the identification of fragmented pathways.

Healthcare settings for care journeys with process mining application

Among the 39 studies analyzed, 33% (n=13) were conducted in hospital settings, while 26% (n=10) occurred in outpatient settings. An additional 18% (n=7) encompassed both outpatient and hospital environments, reflecting investigations that crossed different levels of healthcare. A further 23% (n=9) of studies corresponded to reviews that, although not restricted to a specific clinical setting, provide conceptually and methodologically relevant syntheses of the care contexts evaluated. These findings demonstrate the predominance of studies conducted in hospital environments, followed by outpatient research and reviews, outlining a diverse panorama of investigated settings.

Table 1 Distribution of studies by setting and use of Process Mining (PM)

Setting	Process Mining Used (Yes)	Process Mining Used (No)
Outpatient	2	8
Outpatient and Inpatient	3	4
Inpatient	9	4
Review	2	7
Total	**16**	**23**

Source: The authors, 2026.

As shown in Table 1, when relating study setting to the use of PM, hospital-based studies present the highest proportion of adoption of this methodology, suggesting greater analytical maturity and availability of structured data in that environment. In contrast, in outpatient settings, only two studies employed PM while eight did not, evidencing limitations related to systematic data recording and the complexity of longitudinal patient tracking outside institutional inpatient settings. In the combined outpatient and hospital setting, there was relative balance, indicating that transitions of care between service levels favor the need for analytical tools for information integration. In the review category, the absence of practical PM application predominated, which is expected given that reviews tend to discuss methodological potential and field gaps rather than empirical data mining. This overall distribution suggests that the hospital environment remains the most fertile ground for PM application, while outpatient settings represent a promising space for future investigation.

Proposed conceptual framework for the fragmented care journey

Based on the results of this study, a conceptual framework is proposed for the fragmented care journey, structured around four interdependent dimensions: Care Pathway, Health Information Systematization, Temporality, and Health Governance. This proposal emerges from the identified absence, in the analyzed literature, of an explicit conceptual delineation for the phenomenon, even though its elements are recurrently described in studies on care continuity, care integration, and clinical flows. Accordingly, care journey fragmentation should be understood as a systemic phenomenon resulting from the interaction among clinical, organizational, informational, and temporal factors, as these collectively compromise the comprehensiveness of care.

The Care Pathway dimension refers to the organization of the care route and the manner in which care is structured across different points of care delivery. The literature shows that clinical pathways typically represent a normative or ideal route, oriented toward the standardization of conduct and protocols and optimized patient flow, but are frequently insufficient to address the complexity of patients with multimorbidity, prolonged needs, or non-linear trajectories [7, 22]. In such cases, the persistence of a

disease-centered paradigm may amplify the risk of disarticulation among specialties, services, and clinical decisions. Patient-centered, interprofessional collaboration-based approaches tend to favor greater continuity and care coherence [20, 24, 21]. Within this framework, fragmentation emerges when the patient's actual trajectory diverges from coordinated, longitudinal, and individually responsive care.

The Health Information Systematization dimension corresponds to the capacity to record, integrate, share, and retrieve information throughout the care trajectory. The included studies indicate that the absence of interoperability, the coexistence of silo systems, and restrictions on access to the complete patient record produce significant disruptions in clinical work and in coordination among professionals and services [28, 29, 31]. The lack of informational integration compromises the longitudinal view of care and promotes duplications, gaps, and delays, with repercussions on care cost and quality [27, 30]. Thus, informational fragmentation is not merely a technological limitation but a structural element of care discontinuity.

The Temporality dimension expresses the distribution of care events over time, including waiting periods, delays, intervals between interventions, duration of the diagnostic-therapeutic pathway, and temporal variability across trajectories. Studies indicate that the prolongation of diagnostic pathways, secondary waiting times, and the temporal dispersion of interventions can compromise both the patient experience and clinical effectiveness [33, 19, 32]. Fragmentation also manifests when care loses temporal continuity, whether through avoidable delays or through misalignment between decisions, records, and care execution. Time therefore ceases to be merely an operational attribute and becomes a central analytical component of the fragmented care journey.

The Health Governance dimension encompasses institutional arrangements, workforce organization, and the political-administrative capacity to sustain integrated care models. The reviewed literature shows that care integration depends on effective coordination among professionals, services, and levels of care, as well as on organizational structures capable of aligning risk, cost, quality, and shared responsibilities [36–38]. In systems marked by intense decentralization, low regulation, or weak inter-institutional coordination, governance tends to reproduce the fragmentation already observed at the care and informational levels [39]. In this framework, governance operates as a cross-cutting dimension, as it influences how flows, information, and decisions are articulated or interrupted throughout the journey.

The lack of integration among these four dimensions results in observable effects such as care discontinuity, care inefficiency, and undesirable outcomes. These effects should be understood as manifestations of a multidimensional phenomenon in which ruptures compromise the comprehensiveness of care. This framework allows for a move from a generic conception of "fragmentation" toward a more structured analytical approach, contributing both to the interpretation of the findings of this review and to the development of future investigations or applications.

In this context, PM is incorporated into the framework as the primary methodological approach for analytical operationalization. As described in the literature, this technique enables the reconstruction of real trajectories from event logs, the identification of deviations from expected flows, the mapping of

bottlenecks, the recognition of hidden patterns, and support for care performance and compliance analysis [10, 11, 33, 43]. In the health context, its relevance is particularly notable in allowing the observation of the patient's actual pathway beyond prescribed flows, capturing variations, waiting times, transitions, and discontinuities that are often not evidenced by traditional indicators or normative descriptions of care pathways [19, 41, 23]. Thus, the proposed framework not only conceptually structures the fragmented care journey but also guides a methodological path for its future detection and monitoring.

In light of this framework, the fragmented care journey can be understood as the care trajectory marked by discontinuities among events, professionals, services, information, and decisions, arising from coordination failures across the care, informational, temporal, and governance dimensions, with repercussions on care continuity, coordination, and comprehensiveness. This definition consolidates the theoretical contribution of the study by integrating previously scattered attributes from the literature into a structured conceptual model amenable to application in future analytical and computational investigations.

Fig. 2 synthesizes the proposed conceptual framework, highlighting the convergence of the four dimensions around the fragmented care journey, its main consequences, and the role of process mining as an analytical layer for detecting and monitoring the phenomenon.

[Figure 2 near here]

Fig. 2 Conceptual framework of the fragmented care journey. Based on care, informational, temporal, and governance dimensions. Source: The authors, 2026.

Discussion

The results of this scoping review indicate that the fragmented care journey remains a conceptual gap, permeated by multifactorial phenomena, clinical and operational variability, and systemic limitations in information integration. The literature still lacks consensual indicators that would allow the objective measurement of the degree of discontinuity, as well as the establishment of comparisons among different institutions, populations, and health systems.

In this context, PM can contribute to the operationalization of care fragmentation through indicators derived from clinical event logs. Among the possible indicators are the number of transitions among services or institutions throughout the journey, the time between critical care events, the occurrence of care loops or re-entries into the system, the presence of rare or highly variable trajectories, prolonged temporal gaps between encounters, and deviations from expected care pathways. These indicators allow for the objective measurement of fragmentation, supporting the identification of critical points and informing interventions aimed at improving care continuity.

On this basis, the fragmented care journey is proposed to be understood as the care trajectory marked by discontinuities among events, professionals, services, information, and decisions, which compromise care continuity, comprehensiveness, and coordination. These gaps are expressed through care failures, temporal misalignments, and systemic and governance weaknesses that hinder the articulation among actors, flows, and information. Fragmentation can be understood as a multidimensional phenomenon observed both in patient-centered actions and in the structure of health systems.

The search strategy prioritized widely recognized databases and employed MeSH descriptors; however, the terminological heterogeneity of the field may have limited the retrieval of studies that address similar phenomena through different expressions. Even so, this study achieved sufficient diversity of settings, approaches, and study types to consistently demonstrate the absence of a defined concept of "fragmented care journey" and to support the proposed characterization of the dimensions presented.

This study focused on journeys in outpatient settings; however, the identified literature proved to be distributed across different care contexts, including hospital environments, specific care programs, and review studies. This reinforces that fragmentation extends beyond isolated levels of healthcare and demonstrates that the outpatient context remains underexplored, particularly in PM application studies.

Although this review did not aim to construct or validate a computational model, its results allow for the delineation of pathways for future operationalization. PM proves to be a relevant methodological tool for identifying unwanted pathways. The integration of clinical, operational, and administrative data, combined with the adoption of analytical technologies such as PM, appears a promising path for identifying bottlenecks, reducing waiting times, standardizing conduct, and mitigating the effects of care fragmentation. The four dimensions identified translate into significant space for future investigations that incorporate dynamic monitoring, predictive analysis, and automated decision support, especially in care networks with multiple contact points.

Abraham et al. [20] note that a patient-centered approach is grounded in the identification and capture of contextual factors that influence care continuity among the different professionals involved in patient care. This continuity underpins a comprehensive and integrated practice, allowing care to be understood as a coordinated and uninterrupted succession of events adjusted to the specific needs of each individual. Detro et al. [8] argue that providing process model personalization recommendations is fundamental in the health context, where different treatments may be indicated for distinct sets of clinical factors. However, ensuring this continuity throughout the care process remains one of the great challenges in the field.

These contributions are expected to serve as an initial conceptual framework for the theoretical development and refinement of the term "fragmented care journey," as they contribute to organizing attributes that had previously appeared in a dispersed manner across the literature and offer an initial basis for transforming a complex care problem into an object analyzable by computational methods. This review is therefore not merely descriptive of the literature but will support more precise interventions in the delineation of care flows, the identification of critical discontinuity points, the

detection of infrequent behaviors, and the implementation of strategies that promote the comprehensiveness of healthcare.

Conclusions

This scoping review organized, for the first time, the elements characterizing care journey fragmentation into four conceptual dimensions: Care Pathway, Health Information Systematization, Temporality, and Health Governance. The absence of an explicit conceptual definition of the "fragmented care journey" in the literature was confirmed, reinforcing the theoretical contribution of this study. Process mining emerged as a methodologically relevant tool, predominantly applied in hospital settings, with the outpatient context remaining a promising but underexplored area. The conceptual framework proposed here provides a structured basis for future analytical and computational investigations aimed at identifying, measuring, and mitigating care fragmentation.

Declarations

Ethics declaration:

not applicable.

Acknowledgements

We express our deep gratitude to the academic advisors for their attentive guidance, valuable intellectual contributions, and support throughout all stages of this research. Their confidence and mentorship were essential to the construction of this study and to our academic development.

Competing interests

The authors declare no competing interests.

Funding

Self-funded by the authors.

Authors' contributions

JP and CM conceived and designed the study. JP, GSB, KSS, GSM conducted the systematic search and study selection. JP, GSB, KSS, GSM, SOI, SPD, ADLM, EAPS, MRD performed data extraction and analysis. JP and CM drafted the manuscript. All authors reviewed, revised, and approved the final version.

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article (and its additional files). The review protocol is registered at the Open Science Framework:

https://doi.org/10.17605/OSF.IO/HG42U.

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Figures

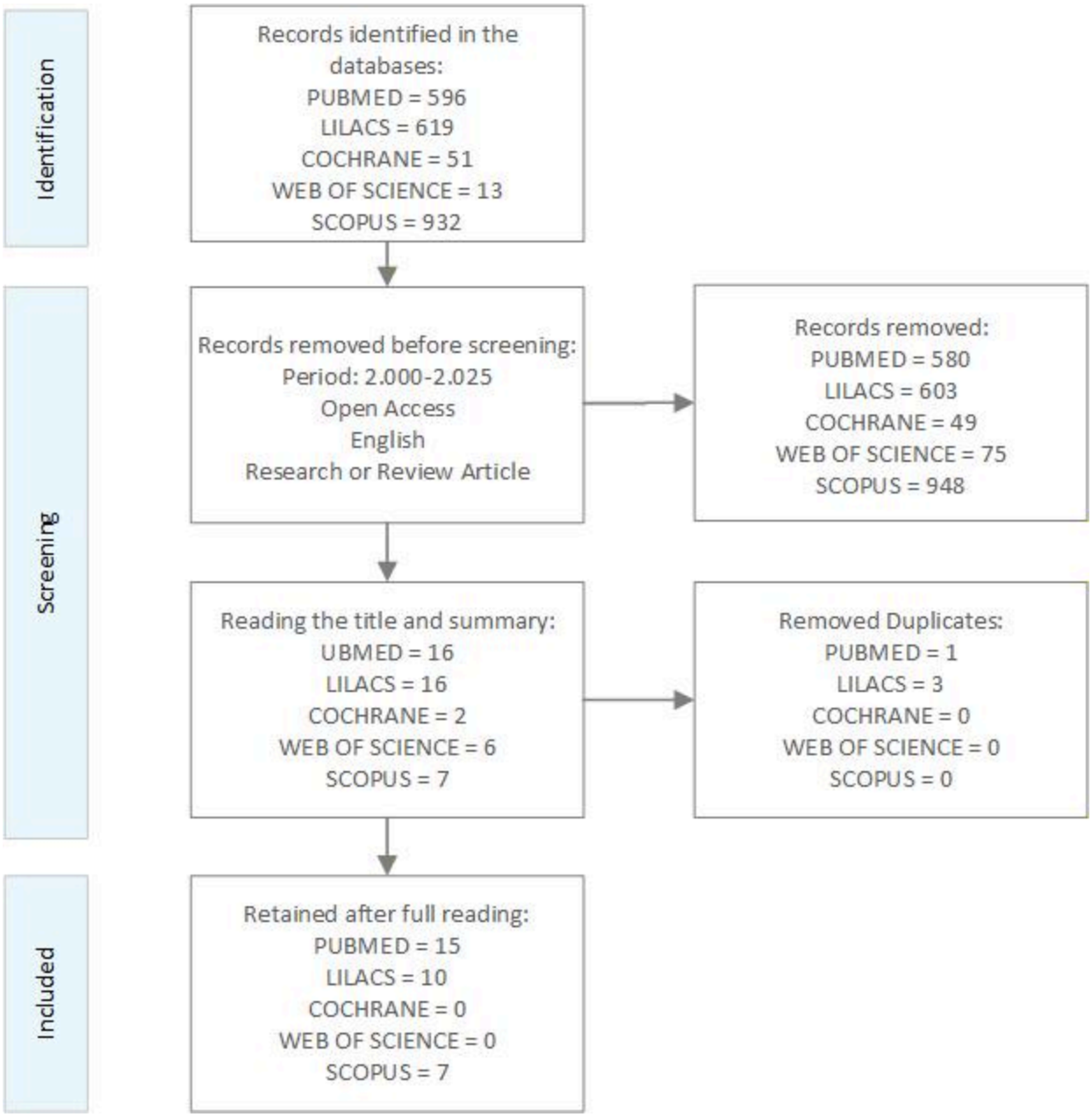


Figure 1

PRISMA-ScR flowchart

PRISMA-ScR: Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews. Source: The authors, 2026.

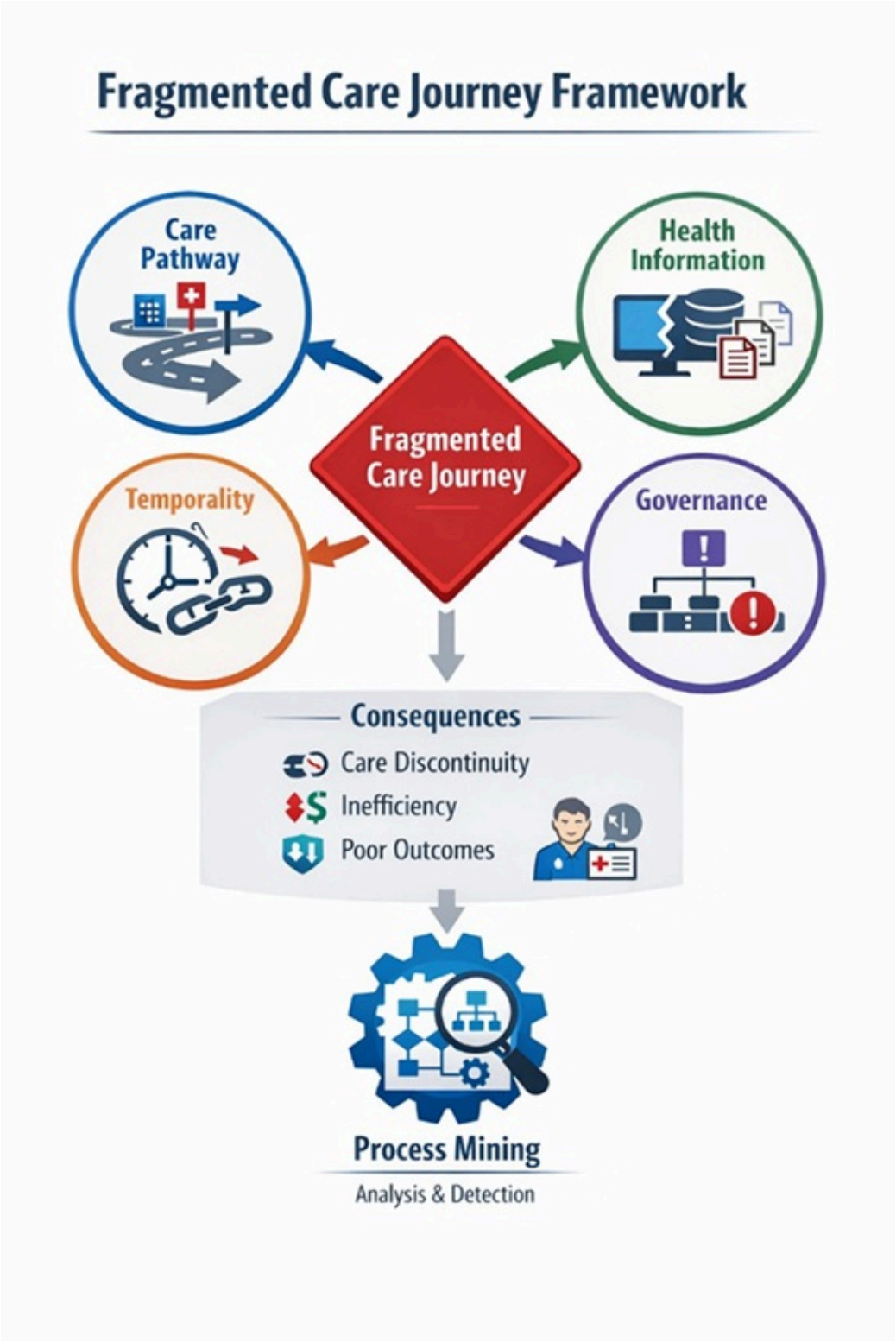


Figure 2

Conceptual framework of the fragmented care journey

Based on care, informational, temporal, and governance dimensions. Source: The authors, 2026.

Supplementary Files

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- Appendix1.xlsx