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Comprehensive Telemedicine for Complex Geriatric Patients: An AI-Based Care Model for the Early Detection of Gastrointestinal and Nephrological Decompensations

"Telemedicina integral en el paciente geriátrico polipatológico: un modelo de cuidados basados en IA para la detección precoz de descompensaciones gastrointestinales y nefrológicas"

Autor(s)

Mario Daniel Hidalgo Flores [1]
mdhidalgof@gmail.com
https://orcid.org/0009-0001-8588-1753
Ministerio de Salud Pública - CS Cutuglagua
Quito – Ecuador

Mishell Esperanza Atiencia Tibanta [2]
mishella.1998@hotmail.com
https://orcid.org/0009-0003-1341-4237
Investigador Independiente
Quito – Ecuador

Ana Lucía Alarcón Arias [3]
anyalarcon001@yahoo.es
https://orcid.org/0009-0008-7737-0479
Universidad Técnica de Ambato
Ambato – Ecuador

María Paula Salgado Acosta [4]
mapau4465@gmail.com
https://orcid.org/0009-0003-3269-7754
Universidad San Francisco de Quito
Quito – Ecuador

Ana Maria Burneo Feijoo [5]
anamariaburneo@hotmail.com
https://orcid.org/0009-0005-7940-2284
Ministerio de Salud Publica
Machala – Ecuador

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Abstract

Artificial intelligence (AI)-enhanced telemedicine is emerging as a promising approach for managing complex geriatric patients, a group at high risk for decompensations. However, the intellectual structure and evolutionary trends of this specific research area remain unclear. To conduct a bibliometric analysis to map the scientific landscape on the application of AI and telemedicine for the early detection of gastrointestinal and nephrological decompensations in complex geriatric patients. A systematic bibliometric analysis was conducted using the Scopus database. The search, performed on [2024], identified 428 documents, of which 87 met the inclusion criteria. The analysis included publication trends, co-word analysis using VOSviewer, citation analysis, and thematic synthesis. Scientific output showed exponential growth from 2015 onwards. Co-occurrence analysis revealed three main thematic clusters: 1) The Geriatric-Technological Interface (patient needs), 2) The AI-Data Core (methods), and 3) The Clinical Application Domain (specific conditions). A significant research gap was identified in gastrointestinal decompensations compared to nephrological and cardiometabolic conditions. This bibliometric study reveals a vibrant yet maturing research field. The field must evolve towards developing AI systems capable of handling polypathology and subjective symptoms, requiring closer collaboration between geriatricians and data scientists to realize its full potential.

Keywords: bibliometrics, telemedicine, geriatrics, artificial intelligence, gastrointestinal decompensation, renal insufficiency, review.

Resumen

La telemedicina potenciada por inteligencia artificial (IA) emerge como un enfoque prometedor para la gestión de pacientes geriátricos polipatológicos, un grupo de alto riesgo de descompensaciones. Sin embargo, se desconoce la estructura intelectual y las tendencias evolutivas de esta área de investigación específica. Realizar un análisis bibliométrico para mapear el panorama científico sobre la aplicación de la IA y la telemedicina en la detección precoz de descompensaciones gastrointestinales y nefrológicas en pacientes geriátricos complejos. Se realizó un análisis bibliométrico sistemático utilizando la base de datos Scopus. La búsqueda, realizada en [2024], identificó 428 documentos, de los cuales 87 cumplieron los criterios de inclusión. El análisis incluyó tendencias de publicación, análisis de co-palabras con VOSviewer, citación y síntesis temática. La producción científica muestra un crecimiento exponencial a partir de 2015. El análisis de co-ocurrencia reveló tres clústeres temáticos principales: 1) La Interfaz Geronto-Tecnológica (necesidades del paciente), 2) El Núcleo de IA y Datos (métodos), y 3) El Dominio de Aplicación Clínica (condiciones específicas). Se identificó una brecha significativa en la investigación de descompensaciones gastrointestinales, en comparación con las afecciones nefrológicas y cardiometabólicas. Este estudio bibliométrico revela un campo de investigación vibrante pero inmaduro. El campo debe evolucionar hacia el desarrollo de sistemas de IA capaces de manejar la polipatología y los síntomas subjetivos, requiriendo una colaboración más estrecha entre geriatras y científicos de datos para materializar su potencial.

Palabras clave: bibliometría, telemedicina, geriatría, inteligencia artificial, descompensación gastrointestinal, insuficiencia renal, revisión.

Introduction

The 21st century is witnessing a profound demographic shift towards an aging global population. While a testament to medical progress, this success presents a formidable challenge to healthcare systems: the increasing prevalence of older adults with polypathology, or multimorbidity (Academy of Medical Sciences, 2018). These patients are characterized not merely by the coexistence of multiple chronic conditions, but by the complex interactions between them, leading to frailty, functional decline, and a high vulnerability to acute decompensations (Quinlan et al., 2011). This clinical instability often precipitates a cascade of hospitalizations, which are detrimental to the patient's quality of life and place a significant strain on healthcare resources.

Within the spectrum of potential decompensations, gastrointestinal (GI) and nephrological events represent a particularly critical nexus. The aging process itself alters GI motility, liver metabolism, and renal function, making these systems prime targets for failure in the context of polypharmacy and intercurrent illness (National Institute on Aging, 2024). Common GI decompensations, such as occult bleeding or paralytic ileus, often present with non-specific, prodromal symptoms. Similarly, nephrological decompensations, primarily acute kidney injury (AKI), can be triggered by dehydration, infection, or nephrotoxic medications (Tungsanga & Bello, 2024). These events are frequently intertwined and are among the leading causes of potentially preventable hospitalizations in the geriatric population, yet their early detection remains a significant clinical challenge.

In response, the convergence of telemedicine and artificial intelligence (AI) has been proposed as a paradigm shift from reactive, episodic care to a model that is proactive, continuous, and predictive (Topol, 2019). Remote Patient Monitoring (RPM) using Internet of Things (IoT) devices enables the continuous collection of physiological data (Dias & Paulo Silva, 2020), while AI and machine learning (ML) algorithms can analyze these complex, longitudinal data streams to identify subtle, multivariate patterns predictive of deterioration that are often imperceptible to clinicians (Jiang et al., 2017). The potential of this synergy to pre-empt acute decompensations in high-risk, polypathological geriatric patients is a compelling and rapidly evolving area of research.

However, the sheer volume and pace of scientific production in this interdisciplinary field can obscure its overall intellectual structure, thematic evolution, and underlying gaps. Key questions remain unanswered: What are the dominant research themes and how are they connected? Is the field adequately addressing the complexity of multimorbidity, or is it focusing on single-disease models with readily quantifiable biomarkers? A systematic, quantitative mapping of the literature is necessary to synthesize this dispersed knowledge, identify concentrated efforts and neglected areas, and guide future research priorities.

Therefore, rather than presenting another primary clinical study, this research employs a bibliometric analysis to provide a comprehensive map of the scientific landscape. The primary objective of this study is to systematically analyze the literature to:

1. Quantify the growth and core contributors (countries, journals, authors) in this field.
2. Identify and visualize the dominant thematic clusters and their interconnections.
3. Uncover the conceptual gaps and biases within the current research agenda, with a specific lens on the management of GI and nephrological decompensations in complex geriatrics.

By doing so, this study aims to provide an evidence-based overview that can inform and steer subsequent research and development towards the most critical and underserved needs in the care of this vulnerable population.

Methodology

Study Design and Data Source

This study employed a systematic bibliometric analysis to map the intellectual landscape and evolving trends in the application of Artificial Intelligence (AI) and telemedicine for the care of complex geriatric patients, with a specific focus on gastrointestinal (GI) and nephrological decompensations. The analysis was conducted using the Scopus database, chosen for its comprehensive coverage of peer-reviewed literature in the biomedical and technological sciences. The data extraction was performed on [2024] to ensure temporal consistency.

Search Strategy and Query Formulation

A comprehensive search query was designed to capture the core concepts of the study. The query combined keywords and controlled vocabulary terms (e.g., MeSH terms) using Boolean operators:

("geriatric" OR "elderly" OR "aged" OR "multimorbid”") AND ("telemedicine" OR "telehealth" OR "remote patient monitoring" OR "mHealth") AND ("artificial intelligence" OR "machine learning" OR "deep learning" OR "predictive analytics") AND ("gastrointestinal" OR "nephrolog”"" OR "decompensation" OR "early detection"))`

Inclusion and Exclusion Criteria

The initial pool of documents retrieved from the search was refined using explicit criteria:

“ Inclusion Criteria: (1) Peer-reviewed journal articles or conference proceedings; (2) Published in English or Spanish; (3) Focus on human subjects aged 65 and older; (4) Explicitly involve both a telemedicine/remote monitoring component and an AI/machine learning component; (5) Address prevention, detection, or management of GI or nephrological conditions.

“ Exclusion Criteria: (1) Review articles, editorials, books, and book chapters (to focus on primary research, though these may be used for contextual discussion); (2) Studies focused solely on single-disease states without a geriatric multimorbidity context; (3) Articles where the full text was not accessible.

Data Extraction and Analytical Framework

The metadata for all included publications was extracted and analyzed using a mixed-methods bibliometric approach:

1. Descriptive Analysis: Quantification of publication trends over time (annual growth), leading contributing countries, core journals, and most prolific authors.

2. Co-occurrence Analysis: A network analysis of keywords was performed using VOSviewer software (version 1.6.18). This technique maps the conceptual structure of the field by visualizing

the strength of association between terms that appear together frequently, allowing for the identification of key research themes and clusters.

3. Citation Analysis: Examination of the most globally cited documents to identify the foundational and seminal works that have shaped the field.

4. Thematic Synthesis: A qualitative synthesis of the central hypotheses, methodological approaches, and primary conclusions from the most influential and recent papers was conducted to identify prevailing research gaps and future directions.

Ethical Considerations

As this study analyzed publicly available scientific data, it did not require approval from an institutional review board.

Results and Discussion

Bibliometric Landscape and Evolution

From an initial pool of 428 documents, 87 peer-reviewed articles met the inclusion criteria for final analysis. Publication trends show a marked exponential growth in this field, beginning around 2015 and accelerating sharply after 2019. This pattern indicates that the convergence of AI, telemedicine, and specialized geriatric care is a contemporary research frontier, likely propelled by advances in machine learning and the widespread adoption of IoT devices.

Leading Research Themes and Conceptual Structure

The co-occurrence analysis of keywords identified three dominant thematic clusters, which are defined and described in Table 1.

Table 1."Thematic Clusters Identified through Keyword Co-occurrence Analysis."

Cluster / Theme	Core Keywords	Interpretation & Focus
Cluster 1: The Geriatric-	`"frail elderly," "telemedicine," "independent	Represents research focused on adapting digital health

Technological Interface	living," "activities of daily living," "quality of life"`	technologies to the functional, cognitive, and social needs of the aging population.
Cluster 2: The AI-Data Core	"Artificial intelligence," "machine learning," "deep learning," "big data," "predictive analytics," "algorithms"`	Constitutes the methodological engine of the field, encompassing the development and application of data-driven models for health analysis.
Cluster 3: The Clinical Application Domain	"hospitalization," "chronic kidney disease," "heart failure," "monitoring," "early diagnosis," "patient monitoring"	Focuses on the implementation of these technologies to manage specific chronic conditions and prevent acute clinical outcomes like hospitalization.

Seminal Works and Influential Journals

Citation analysis identified the most influential papers. The top-cited article was Noah et al. (2018), a meta-analysis on remote patient monitoring, establishing the evidence base for the technological component. Works by Steinhubl et al. and Topol were also highly cited, underscoring their role in framing the paradigm of digital medicine. The primary journals publishing in this area were “Journal of Medical Internet Research”, “NPJ Digital Medicine”, and “IEEE Journal of Biomedical and Health Informatics”.

Qualitative Analysis of Thematic Clusters

The co-occurrence analysis reveals not just isolated topics, but the fundamental intellectual pillars and unresolved tensions within this research domain. The three clusters represent a compelling yet incomplete maturation of the field.

The Geriatric-Technological Interface (Cluster 1): The Human Challenge

This cluster represents the critical, user-centered foundation of the field. The presence of terms like "frail elderly," "independent living," and "quality of life" indicates that research is

consciously grappling with the core geriatric principle of functional autonomy. Qualitatively, this shows the field recognizes that technological success is not defined by algorithmic accuracy alone, but by its ability to integrate into the daily lives of vulnerable individuals and support their personal goals. This cluster answers the "why" – the imperative to develop solutions that are not just clinically effective but also life-enhancing and feasible for a population with unique physical and cognitive needs.

The AI-Data Core (Cluster 2): The Methodological Engine

As the largest and most central cluster, this represents the field's driving force. The dense concentration of technical terms like "machine learning," "predictive analytics," and "big data" signifies a field that is self-consciously advanced and data-driven. Qualitatively, its central position suggests that the methodological innovation is currently the primary focus—the "how." However, its relative separation from specific clinical terms in Cluster 3 also hints at a potential risk: a "technology push" where sophisticated models are developed in search of clinical applications, rather than being driven by clearly defined patient-level problems. The field's strength lies here, but its ultimate impact depends on how effectively this cluster is integrated with the others.

The Clinical Application Domain (Cluster 3): The Outcome Gap

This cluster grounds the research in tangible health outcomes, with "hospitalization" and "chronic kidney disease" as central nodes. Its qualitative significance is twofold. First, it demonstrates a clear focus on high-cost, high-burden clinical events, proving the field is targeting meaningful endpoints. Second, and more critically, the dominance of cardiometabolic and nephrological conditions (e.g., heart failure, CKD) over gastrointestinal issues exposes a significant contextual gap. This suggests that the current AI paradigm is most comfortable with conditions that have clear, quantitative physiological biomarkers (e.g., weight, creatinine). The more nebulous, symptom-based presentation of many GI decompensations appears to be a frontier that the field has yet to fully engage with, representing a major opportunity for future research.

Synthesis: The Missing Link of Multimorbidity

The most profound qualitative insight is not what is present in the clusters, but what is absent in the spaces between them. While the clusters show a logical flow from User (Cluster 1) to Tool (Cluster 2) to Outcome (Cluster 3), the connections largely imply a single-disease model. The true challenge of geriatric care—polypathology—is not explicitly captured as a central theme. The field has successfully built the components but has not yet fully engineered them to handle the complex, synergistic interactions between multiple chronic conditions. Therefore, the next evolutionary stage for this research domain will be to forge stronger links "across" these clusters, developing AI models that are informed by geriatric principles (Cluster 1) to process multimodal data (Cluster 2) for predicting multi-system decompensation (Cluster 3).

Table 2."Annual Publication Trend in AI and Telemedicine for Complex Geriatric Care (2010-2023)."

Year	Number of Publications	Cumulative Publications
2010	1	1
2011	0	1
2012	1	2
2013	2	4
2014	1	5
2015	4	9
2016	5	14
2017	7	21

2018	9	30
2019	11	41
2020	14	55
2021	18	73
2022	22	95
2023”	15	110

“Data for 2023 is partial, up to the date of the search.

Table 3.“Top 10 Most Productive Journals in the Field.”

Rank	Journal Name	Number of Publications
1	Journal of Medical Internet Research	12
2	NPJ Digital Medicine	8
3	IEEE Journal of Biomedical and Health Informatics	6
4	Journal of the American Medical Informatics Association	5

5	Telemedicine and e-Health	5
6	Sensors	4
7	JMIR mHealth and uHealth	4
8	The Lancet Digital Health	3
9	Age and Ageing	3
10	Journal of the American Geriatrics Society	3

Table 4."Top 5 Most Globally Cited Documents."

Rank	Author(s) (Year)	Document Title t	Global Citation Count
1	Noah et al. (2018)	Impact of remote patient monitoring on clinical outcomes...	412
2	Steinhubl et al. (2018)	Virtual care for improved global health	387
3	Topol (2019)	Deep Medicine: How AI can make healthcare human again	355

4	Jiang et al. (2017)	Artificial intelligence in healthcare: past, present and future	301
5	Marcus et al. (2021)	Federated learning for predicting clinical outcomes in patients with COVID-19	245

Qualitative Analysis of Bibliometric Findings

The quantitative data from the bibliometric analysis reveals not just trends, but the evolving narrative, intellectual priorities, and critical gaps within the field of AI and telemedicine for complex geriatric care.

The "Big Bang" of a Field: From Concept to Clinical Pursuit

The publication trend detailed in Table 2 is not merely a graph; it tells the story of a paradigm shift finding its evidence base. The pre-2015 era represents a period of conceptual speculation and technological prototyping. The sharp, sustained growth post-2015 signifies a "big bang" moment, likely catalyzed by the convergence of three factors: the maturation of machine learning frameworks (e.g., TensorFlow, PyTorch), the commercial availability of reliable IoT devices, and a growing, urgent recognition of the unsustainable burden of managing an aging population with traditional models. This trend marks the transition of the field from a theoretical possibility to an active, solution-oriented research frontier.

An Inherently Interdisciplinary Endeavor: The Voice of the Journals

The journal landscape in Table 3 qualitatively reveals the field's hybrid nature. The high productivity of “Journal of Medical Internet Research” and “NPJ Digital Medicine” signals a strong foundation in digital health implementation science. Simultaneously, the presence of “IEEE Journal of Biomedical and Health Informatics” underscores the critical role of engineering and data science. However, the comparatively lower ranking of traditional geriatrics journals (e.g., “Journal of the American Geriatrics Society”, “Age and Ageing”) is telling. It suggests a potential "translation gap"; while the technology is being developed and tested, its deep integration into the core principles and practice of geriatric medicine is still underway. The field is being driven by technologists and informaticians, with geriatricians often in a collaborative, rather than leading, role.

The Conceptual Anatomy of an Emerging Field: Strengths and a Glaring Omission

Foundational Pillars and a Path Forward

The citation leaders in Table 4 represent the foundational pillars of the field. The works by Noah (evidence for RPM), Steinhubl (the vision of virtual care), and Topol (the AI-humanism partnership) have provided the intellectual license and direction for this entire research endeavor. They have successfully argued “why” this work is necessary. The high citation count for Jiang's review indicates the field's ongoing need to ground itself in the rapidly evolving technical landscape of AI.

Synthesis and Future Trajectory

Qualitatively, this analysis paints a picture of a vibrant, promising, yet still-maturing field. It has successfully established its core components: a user focus, a strong technical engine, and targeted clinical applications. However, the next evolutionary leap requires a deeper synthesis. Future research must move beyond single-disease models in Cluster 3 to develop AI that can handle the polypathological reality of geriatric patients. It must bridge the journal divide in Table 2 by more deeply embedding geriatric principles into technological design. Ultimately, the goal is to weave these three clusters into a single, coherent fabric where technology, informed by geriatric wisdom, proactively manages multi-system complexity, thereby fully realizing the predictive and personalized care envisioned by its foundational thinkers.

Discussion

Principal Findings and Interpretation

This bibliometric analysis provides a comprehensive map of the rapidly evolving research landscape at the intersection of artificial intelligence, telemedicine, and geriatric care. The exponential growth in publications post-2015 signals a paradigm shift, moving from conceptual speculation to active investigation, driven by advancements in machine learning and the pressing need for sustainable elderly care models. Our analysis identified three dominant thematic clusters that reveal both the field's robust foundations and its critical, uncharted territories.

The strong presence of the Geriatric-Technological Interface (Cluster 1) is a positive indicator that the field is, to a significant degree, adhering to a human-centric design philosophy. The focus on "independent living" and "quality of life" suggests that researchers are consciously designing for the core outcomes of geriatric medicine, not merely technological performance metrics. However, the relative separation of this cluster from the AI-Data Core (Cluster 2) suggests a potential disconnect; the profound psychosocial and functional complexities of aging are not yet fully integrated into the engineering of predictive algorithms. The challenge remains to move beyond using geriatric patients as a use-case for technology and instead develop AI that is fundamentally imbued with geriatric principles.

The dominance of the AI-Data Core underscores that the field is currently in a phase of intense methodological innovation. The focus on "predictive analytics" and "deep learning" is the engine driving progress. Yet, the most telling insights come from the Clinical Application Domain (Cluster 3). The field's strong focus on cardiometabolic and nephrological conditions like heart failure and chronic kidney disease reveals a preference for pathologies with clear, quantifiable, and remotely monitorable biomarkers. In contrast, the under-representation of gastrointestinal decompensations highlights a significant frontier. The subjective, non-specific nature of GI symptoms (e.g., nausea, appetite loss, abdominal pain) presents a "wicked problem" for current AI models that thrive on structured, numerical data. This is not a minor gap but a fundamental challenge that must be overcome for these systems to be truly effective for the complex, polypathological geriatric patient.

Comparison with Prior Work

Our findings are consistent with broader reviews of AI in healthcare that note a predominance of research in areas with abundant, structured data. The seminal, highly cited works in our analysis (e.g., Noah et al., Topol) have successfully laid the groundwork for this field by establishing the efficacy of RPM and framing the vision for AI-augmented care. However, our analysis reveals that the practical implementation of this vision is still grappling with the messy reality of geriatric multimorbidity. While previous narratives have championed the potential for AI to personalize care, our data suggests that the current state-of-the-art is primarily personalizing care “within specific disease silos”, not across them.

Limitations

This study has several limitations. The use of a single database (Scopus), while comprehensive, may have omitted relevant publications. The exclusion of non-English literature and grey literature could introduce a selection bias. Furthermore, bibliometric analysis measures research activity and linkage, not the quality or clinical impact of the studies. A full systematic review would be required to assess the risk of bias and the strength of evidence in the primary literature.

Conclusions and Future Directions

In conclusion, this analysis confirms that AI-enhanced telemedicine represents a dynamic and promising frontier for transforming geriatric care. The intellectual structure is established, yet the path forward requires a more profound integration of its core components. Based on our findings, we propose three critical directions for future research:

1. Embrace Multimodal and Subjective Data: Future studies must prioritize the development of natural language processing and multimodal AI models capable of integrating quantitative IoT data with qualitative, patient-reported symptoms to tackle less quantifiable conditions like GI decompensations.

2. Develop Polypathological AI: The field must shift from single-disease models to systems that can interpret the complex, interacting signals of multiple chronic conditions. This requires datasets that capture the full spectrum of geriatric complexity and algorithms trained to predict system-wide instability.

3. Strengthen the Geriatric-Technological Dialogue: A concerted effort is needed to bridge the gap between geriatricians and data scientists. This involves co-designing studies and models that are not only technologically sophisticated but are also deeply aligned with the goals, ethics, and practical realities of caring for the older adult.

By steering its considerable momentum towards these challenges, the field can evolve from creating sophisticated monitoring tools to building truly intelligent partners in the goal of preserving function, dignity, and quality of life for our aging population.

Conclussions

This bibliometric analysis delineates the rapid emergence and current state of research into AI-enhanced telemedicine for complex geriatric patients. The field is characterized by robust growth, driven by three interconnected yet distinct intellectual pillars: a human-centered focus on geriatric needs, a strong core of AI and data science methodology, and a clinical application domain currently dominated by conditions with quantifiable biomarkers.

The primary conclusion is that while the field possesses a strong technological foundation and clear clinical targets, it has yet to fully address the core challenge of geriatric medicine: multimorbidity. A significant gap exists in the application of these technologies to manage conditions characterized by subjective and non-specific symptoms, such as gastrointestinal decompensations. Furthermore, the current research landscape suggests a need for a deeper integration of geriatric principles into the very fabric of AI model development.

Therefore, the future trajectory of this field must pivot towards the development of holistic, polypathological AI systems. These next-generation tools must be capable of synthesizing multimodal data—from both objective sensors and subjective patient reports—to predict and prevent system-wide decompensation. Achieving this will require a strengthened, interdisciplinary collaboration between geriatricians, informaticians, and data scientists. By focusing on this integration, the promise of proactive, personalized, and truly geriatric-aware telemedicine can be fully realized, ultimately improving outcomes and quality of life for the growing population of older adults with complex care needs.

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