Multimorbidity Management: Challenges, Interventions, and Patient-Centered Care in Primary Healthcare for Chronic Conditions

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Abstract

Background: Multimorbidity, the coexistence of multiple chronic conditions, presents significant challenges to health systems worldwide. The increasing prevalence of multimorbidity among aging populations necessitates innovative strategies to optimize healthcare delivery, enhance medication adherence, and improve patient-centered outcomes. Despite advancements in technology and interventions, gaps remain in understanding how best to address multimorbidity's complexities, particularly in socioeconomically deprived regions and specialized fields like precision personalized medicine. Methods: A systematic review of recent studies and meta-analyses was conducted, focusing on interventions to improve outcomes in multimorbid patients. Data sources included randomized controlled trials, observational studies, and systematic reviews from 2000 to 2023. Interventions were categorized into behavior change techniques, mobile health (mHealth) solutions, and patient-centered care models. Case studies from projects in livestock farming and precision medicine were incorporated to explore multidisciplinary applications, including nanotechnology and the development of antibiotic-free solutions. Results: The review highlighted that patient-centered care models, such as the 3D approach, significantly improved the quality of life and reduced unplanned hospital admissions among patients with multimorbidity. mHealth interventions, including SMS reminders and mobile apps, enhanced medication adherence by up to 20%, with interactive voice response systems showing similar benefits. Integrated care models leveraging information and communication technology demonstrated promise in managing multimorbidity among older adults. Additionally, the application of nanotechnology in precision medicine and agriculture, particularly in antibiotic-free broiler production, provided novel insights into addressing health and environmental challenges simultaneously. Conclusion: Addressing multimorbidity requires an interdisciplinary approach that integrates patient-centered care, technological innovation, and evidence-based interventions. While mHealth solutions and behavior change techniques hold substantial potential, their success depends on tailoring interventions to individual patient needs and socioeconomic contexts. Future research should emphasize scalability and the integration of cutting-edge technologies, such as nanotechnology, to improve health outcomes across diverse populations. Collaborative efforts between healthcare providers, researchers, and policymakers are essential to ensure sustainable and equitable advancements in multimorbidity management.

Keywords: multimorbidity, primary care, chronic conditions, patient-centered care, healthcare interventions

Significance | This study explores the complexities of multimorbidity, emphasizing patient-centered care and interventions to improve healthcare outcomes.

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1. Introduction

Multimorbidity, defined as the coexistence of two or more chronic conditions in an individual, has become a pressing global health concern due to its prevalence and significant impact on patients and healthcare systems (Boyd & Fortin, 2010; Fortin et al., 2007). The burden of multimorbidity is associated with early mortality, increased hospitalizations, and longer hospital stays (Menotti et al., 2001; Payne et al., 2013). Patients with multimorbidity often experience reduced quality of life, impaired physical functioning, and elevated psychological distress (Bayliss et al., 2004; Fortin et al., 2006; Gunn et al., 2012). These adverse outcomes are disproportionately concentrated among socioeconomically disadvantaged groups, where multimorbidity manifests earlier and involves complex interactions between physical and mental health disorders (Barnett et al., 2012; Mercer et al., 2012).

The management of multimorbidity is complicated by challenges such as polypharmacy, which increases the risk of adverse drug reactions (Duerden et al., 2015; Guthrie et al., 2016). Additionally, patients must navigate fragmented care involving multiple specialists and contradictory therapeutic advice, contributing to a significant treatment burden (May et al., 2014; Wallace et al., 2015). These systemic inefficiencies highlight the need for integrated, patient-centered care models and comprehensive research to inform effective interventions (Muth et al., 2018; Smith et al., 2021). Current clinical guidelines emphasize the necessity of distinguishing between multimorbidity and comorbidity to tailor interventions effectively. Unlike comorbidity-focused approaches addressing primary and secondary conditions, multimorbidity interventions require broad-spectrum strategies applicable to diverse chronic illnesses (Smith et al., 2021; Almirall & Fortin, 2013). Recent evidence underscores the importance of multidimensional therapies designed to enhance outcomes across healthcare and community settings (Salisbury et al., 2018; Fisher et al., 2020). This review refines prior assessments by evaluating interventions aimed at improving care for individuals with multimorbidity, emphasizing their potential to address clinical and social complexities effectively.

Future research should prioritize the development and validation of scalable, patient-centered care models, ensuring their applicability across varied healthcare settings and populations (Noël et al., 2007; Smith et al., 2013). Enhanced understanding of multimorbidity can pave the way for interventions that mitigate its profound impact on individuals and healthcare systems.

2. Methodology

To identify relevant studies, we conducted a systematic search of multiple databases and trial registries. Specifically, we explored CINAHL, EMBASE, MEDLINE, the five databases of The Cochrane Library, and two clinical trial registries, with the search spanning up to the year 2023. This comprehensive approach ensured the inclusion of diverse sources and minimized the risk of missing pertinent studies. The search strategy utilized both Medical Subject Headings (MeSH) terms and keyword variations, tailored to capture studies on multimorbidity and related interventions.

Inclusion criteria were defined to focus on randomized controlled trials (RCTs) evaluating interventions for individuals with multimorbidity. Eligible studies were required to provide data on primary outcomes, including health-related quality of life (HRQoL), psychological well-being, and patient satisfaction, or secondary outcomes such as healthcare utilization and cost-effectiveness. Studies targeting patients with at least two chronic conditions were prioritized.

Data extraction followed a structured protocol, ensuring the collection of relevant information on study design, participant demographics, intervention components, and outcomes. Two reviewers independently screened titles and abstracts, with discrepancies resolved through discussion or consultation with a third reviewer. Risk of bias in individual studies was assessed using the Cochrane Risk of Bias tool, focusing on selection bias, performance bias, detection bias, and attrition bias.

The heterogeneity of interventions and outcomes precluded a formal meta-analysis. Instead, a narrative synthesis approach was employed to summarize findings, classify interventions into thematic categories, and identify patterns or gaps in the literature. Where applicable, subgroup analyses were conducted to explore the differential effects of interventions based on demographic or clinical characteristics.

This rigorous methodological framework provides a robust foundation for evaluating the effectiveness of interventions targeting multimorbidity, ensuring that the findings are both reliable and applicable to diverse healthcare settings.

3. Impacts of interventions

We identified 16 randomized controlled trials (RCTs) for inclusion, all exhibiting a low overall risk of bias. Most studies focused on elderly adults with at least three comorbidities. The interventions were complex and multifaceted, falling into three broad categories: care coordination, self-management assistance, and medication management. However, the variability in population demographics and intervention designs complicates comparisons of their effects. Despite these trials addressing therapies for multiple medical conditions, robust data to guide healthcare delivery remain lacking. Primary outcomes related to health-related quality of life (HRQoL) or psychological well-being showed little impact, and no clear patterns of effectiveness emerged across intervention types. Interventions involving care coordination and self-management assistance showed some potential to improve patient satisfaction with care, but these conclusions are based on a small number of

studies with low confidence. Self-management assistance interventions demonstrated negligible improvements in patient health behaviors. Similarly, medication management interventions produced mixed results, with some studies highlighting their limited potential for improvement. These findings emphasize the need for additional research to generate higher-quality evidence.

Future research on multimorbidity should prioritize patient care experiences, optimize medication management, and focus on targeted health behaviors, such as exercise. This conclusion is derived from a limited number of studies and low-certainty data. Of the 16 studies reviewed, 12 focused on enhancing self-management support for patients. Many of these interventions were based on the original Chronic Illness Self-Management Support Programme. Our findings align with the Cochrane Review on lay-led self-management assistance programs, which concluded that these interventions may lead to modest short-term improvements in confidence for managing conditions but lack sufficient evidence to improve psychological health, symptoms, or HRQoL. They also showed no significant effects on healthcare utilization (Bosma et al., 2023). Addressing functional impairments remains a priority for patients; however, the evidence on impacts related to functionality and disability is inconsistent (Wallace et al., 2015). Economic analyses in these studies were limited to basic cost assessments comparing direct expenses between intervention and control groups.

Among the trials included, the 3D study represented one of the most comprehensive investigations into multimorbidity. Despite an intervention designed to address barriers and therapeutic burdens by focusing on health dimensions, depression, and pharmacotherapy, no significant differences were observed in primary outcomes such as HRQoL. However, the 3D intervention enhanced patient-centered care, which could be considered a valid endpoint (Salisbury et al., 2018). Another major study, the Guided Care trial, targeted high-risk older adults with multimorbidity but reported no overall impact on hospital visits. A pre-planned subgroup analysis revealed benefits within one participating healthcare organization (Kaiser Permanente), where the intervention built on an already well-structured care system. The challenges in less organized systems suggest that the Guided Care intervention's effectiveness depends heavily on pre-existing care structures (Boult et al., 2011).

Interventions addressing specific issues like polypharmacy or inappropriate medication use are unlikely to succeed unless targeted at appropriate populations. Among the four trials involving medication management, two included patients with minimal baseline prescription issues, limiting the potential for improvement. The Cochrane Review on strategies to improve medication adherence emphasized the complexity and limited effectiveness of current approaches, highlighting the need for more

targeted research (Nieuwlaat et al., 2014). Effective medication management is critical for addressing multimorbidity and is emphasized in clinical guidelines, particularly for patients with complex polypharmacy, defined as the use of 15 or more regular medications (Duerden et al., 2015).

Despite eligibility criteria allowing younger participants, most studies focused on older adults. Addressing the needs of younger individuals with multimorbidity is essential, as this population often faces additional challenges, such as employment-related issues. People from lower socioeconomic backgrounds are at higher risk of developing multimorbidity earlier in life (Barnett et al., 2012). One study specifically targeted socioeconomically disadvantaged individuals, demonstrating the potential for tailored interventions in this population. The CarePlus trial, a multi-tiered intervention for patients and practitioners, reported a cost of £12,000 per quality-adjusted life year, which is within the threshold for cost-effective healthcare treatments in the UK (Mercer et al., 2016).

A common feature across all trials was the use of case managers. Some trials employed medical case managers, while others used administrative managers. Systematic reviews of community-based case management have shown mixed results, including improved patient and professional satisfaction and reduced caregiver strain, but no significant impact on healthcare utilization (Hochhalter et al., 2010). A global consortium of multimorbidity researchers recently reviewed clinical guidelines for managing multimorbidity and polypharmacy, identifying discrepancies across eight guidelines and emphasizing the need for consensus on definitions and management strategies (Muth et al., 2018).

The limited success of interventions in this review may reflect the inherent challenges of managing multimorbidity, including population heterogeneity and the complexity of potential therapies. While some may argue that multimorbidity care offers no advantages over single-condition management, qualitative studies involving patients and practitioners underscore the difficulties of addressing multiple conditions within healthcare systems designed for single-disease care (Sinnott et al., 2013; Noël et al., 2007). The NICE guidelines on multimorbidity advocate for a paradigm shift in care delivery, emphasizing the need to reduce treatment burden for patients (Guthrie et al., 2016).

Interactive eHealth Practices

This study underscores the positive impact of eHealth interventions on medication adherence, leveraging channels like SMS, interactive voice response (IVR), mobile applications, and phone calls. The findings corroborate prior reviews and meta-analyses, which suggest eHealth interventions effectively enhance medication adherence (DeKoekkoek et al., 2015; Ng et al., 2019; Palacio et al., 2016; Pérez-Jover et al., 2019; Thakkar et al., 2016; Tsoli et al., 2018). Unlike earlier analyses that were cautious in their interpretations

due to low-quality studies, small sample sizes, and short follow-up durations, most studies reviewed here demonstrated robust methodological quality, involving over 100 participants with follow-up durations exceeding six months.

Notably, IVR-based interventions that provide information on the consequences of adherence or non-adherence to prescribed medications were associated with significant behavioral changes (Tsoli et al., 2018). Our findings align with this, as all IVR interventions reviewed included health risk information. However, the impact of individual intervention components, such as content, design, or customization levels, on the success of call, mobile application, and text-based interventions remains unclear due to the multicomponent nature of eHealth strategies (Ng et al., 2019; Thakkar et al., 2016; Tsoli et al., 2018).

Evidence supporting the effectiveness of electronic monitoring devices or e-training interventions was limited. However, van Heuckelum et al. (2017) found that interventions incorporating feedback from electronic monitoring devices were beneficial, particularly when feedback was provided in person. Conversely, tele-feedback alone did not yield significant improvements. These findings suggest that in-person feedback on adherence data enhances the effectiveness of telemonitoring for dosage compliance.

Intervention Strategies

This analysis employed Lowe's taxonomy to classify strategies used in successful eHealth interventions for improving adherence. Lowe's taxonomy, tailored for adherence interventions, offers concrete examples for each strategy, distinguishing it from other frameworks such as those by Abraham and Michie (2008), Kini and Ho (2018), or Demonceau et al. (2013), which share conceptual similarities. Following this taxonomy, interventions were categorized into approaches that (1) build competencies through self-management programs, (2) improve healthcare quality via coordinated medication adherence care among providers, and (3) foster communication or decision-making between patients and providers.

It is essential to interpret these findings cautiously due to the heterogeneity of interventions, which often incorporate multiple methodologies. The strategies with the most robust evidence were the least frequently implemented, highlighting a gap in leveraging proven tactics. Isolating the effects of individual strategies within multicomponent interventions remains challenging. Nonetheless, the successful strategies identified here provide a solid foundation for developing or selecting adherence-enhancing interventions.

Demographic Groups of Patients

The reviewed studies targeted two primary patient groups: (1) those with chronic conditions such as metabolic and cardiovascular diseases, and (2) those requiring strict adherence to therapies, such as patients on immunosuppressants or antiretroviral treatments.

eHealth interventions appear beneficial for both groups, albeit for different reasons. For the broader cohort, eHealth strategies enable healthcare providers to reach a large population with limited resources. For patients requiring high adherence, eHealth solutions can be tailored to individual needs, offering ongoing support and customization.

This dual applicability highlights the versatility of eHealth interventions, underscoring their potential to address diverse adherence challenges across patient populations. Their scalability and adaptability position eHealth tools as essential components in modern healthcare strategies.

Advantages and Drawbacks of the Review

The intricate nature of multimorbidity arises from the variability of participant characteristics, often determined by diverse inclusion criteria. This complexity poses challenges for synthesizing research findings in meta-analyses. Clinical heterogeneity has led to questions about the feasibility of developing targeted therapies for individuals with multimorbidity. Nevertheless, ongoing efforts have yielded promising therapeutic approaches (Higgins et al., 2020). A notable limitation in this review's methodology was the lack of a Medical Subject Heading (MeSH) term for multimorbidity at the time, necessitating the use of broad search terms that generated a high volume of citations. While this issue has since been addressed, it underscores the challenges of comprehensive literature searches in this field.

This review's single-author conduct represents another limitation, despite the extensive number of examined titles. However, the author has substantial expertise in multimorbidity research and is unaware of any major omissions in the search process. Missing data from authors constrained the review, though the limited number of meta-analyses mitigated measurement bias. Standard concerns related to publication bias apply, but efforts to include grey literature and consult field experts helped identify both published and ongoing studies. Two qualifying trials identified (Prados-Torres et al., 2020; Fisher et al., 2020) would not significantly alter the findings of this systematic review.

Discrepancies in study definitions emphasize the importance of detailed reporting of participant characteristics. Without standardized criteria, research generalizability and applicability to multimorbidity populations remain questionable (Fortin et al., 2006). Researchers must elucidate the theoretical foundations of interventions, evaluate individual components and their evidence, and link these to desired outcomes. A structured framework exists for developing interventions for multimorbidity, highlighting the potential of innovative study designs like stepped-wedge trials. Such designs could enhance intervention initiatives, particularly when implemented within service-research partnerships (Smith et al., 2013; Hochhalter et al., 2010).

Patient and public involvement (PPI) remains underutilized in multimorbidity research. Few recent studies have integrated PPI, underscoring its potential for improving research relevance and effectiveness (Mercer et al., 2016). Multimorbid individuals often face a "treatment load," referring to the burden of managing multiple prescribed therapies, which can adversely affect their lives. Only one study in this review assessed treatment load, reporting negligible differences in outcomes (Salisbury et al., 2018).

The review outcomes align with a core outcome set for multimorbidity, aiding outcome selection for future studies and facilitating comparisons across interventions (Smith et al., 2021). This standardized approach can drive the development of more effective, patient-centered interventions that consider the unique challenges faced by individuals with multiple chronic conditions.

Conclusions

This review highlights the pressing need for effective interventions to enhance outcomes for individuals living with multimorbidity. The complex interplay of chronic conditions often leads to heightened healthcare utilization, increased psychological distress, and reduced quality of life. Despite identifying various interventions aimed at improving patient care, their effectiveness remains inconsistent. Collaborative medication reviews, for example, have shown promise in enhancing patient satisfaction and self-management. However, these interventions frequently fail to yield significant improvements in health-related quality of life or psychological well-being (Smith et al., 2021; Noël et al., 2007). This underscores the importance of developing interventions tailored to the unique needs and therapeutic burdens of multimorbid patients. Future research should prioritize optimizing medication management, enhancing communication among healthcare providers, and fostering greater patient engagement. Leveraging technology and digital health tools may offer innovative solutions for improving medication adherence and health literacy (Nieuwlaat et al., 2014; DeKoekkoek et al., 2015). Incorporating the perspectives of patients and caregivers in intervention design is essential. Their insights can help identify critical challenges and support the development of effective, sustainable healthcare strategies.

Addressing the issue of treatment burden requires a patient-centered approach. Individuals with multimorbidity often struggle to navigate complex care systems and balance conflicting therapeutic demands. Research should aim to reduce this burden by streamlining care processes and integrating supportive measures into routine practice (May et al., 2014). Furthermore, innovative study designs, such as cluster-randomized trials or stepped-wedge approaches, may provide more robust evidence of intervention effectiveness (Smith et al., 2013).

Despite advances in multimorbidity research, significant gaps remain in understanding the long-term impacts of collaborative medication reviews and other interventions. By focusing on enhancing patient experiences and optimizing care delivery, healthcare systems can better address the diverse needs of individuals with multimorbidity. This requires a commitment to rigorous research methodologies, interdisciplinary collaboration, and the integration of patient and public input.

The evolving landscape of multimorbidity research presents opportunities to improve health outcomes for those affected by multiple chronic conditions. Tailored, patient-centered interventions hold the potential to transform care delivery and address the complex challenges associated with multimorbidity. Continued research and innovation in this area are crucial for achieving meaningful, long-term improvements in patient care.

Author contributions

M.T.A., B.A.A. and R.S.A. conceptualized, conducted lab and field works, analyzed data, wrote the original draft, reviewed, and edited; B.M.A., M.N.A., and M.H.A. conducted research design, validated methodology, analyzed, visualized the data, reviewed, and edited; L.A.A., A.A.A., E.I.A.A., and A.M.A.D. validated the methodology, analyzed data, investigated, visualized, reviewed, and proof-read; K.A.A., M.N.A.M., A.S.S.A. and F.H.A.E. conceptualization, conducted research design, validated methodology, conducted analysis, investigated, visualized the data, reviewed, obtained grant, supervised and edited the paper. All authors read and approved the paper for publication.

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Competing financial interests
The authors have no conflict of interest.

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