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Research on Nursing Burden and Optimization of Management Models for Elderly Patients with Multimorbidity in the Context of Smart Aging

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Abstract. Population aging has created unprecedented healthcare challenges, particularly for elderly patients with multiple chronic conditions. With 75% of Chinese elderly managing two or more conditions, family caregivers face substantial burden, with over 60% experiencing moderate to severe strain levels. Current healthcare systems show significant limitations including fragmented information across care settings, lack of individualized approaches, and digital accessibility gaps affecting vulnerable populations. These challenges require comprehensive solutions integrating advanced technology with streamlined management frameworks. This study proposes a transformative "Medical-Care-Nursing Integration with Smart Technology Support" model combining Internet of Things monitoring, AI-driven predictive analytics, and virtual reality rehabilitation platforms. The approach addresses existing limitations through enhanced real-time monitoring, immersive rehabilitation technologies, comprehensive care networks, and participatory models emphasizing caregiver empowerment and digital inclusion. The research contributes evidence-based strategies for reducing caregiver burden while improving patient outcomes. This multidisciplinary approach offers practical pathways for healthcare systems to adapt to aging populations through technology-enhanced care delivery. Implementation requires coordinated efforts across healthcare institutions, community organizations, and technology providers to ensure equitable access and sustainable care for elderly patients with multimorbidity.

Keywords: multimorbidity, elderly care, nursing burden, smart aging, healthcare technology, caregiver support

1. Introduction

The twenty-first century demographic transformation fundamentally reshapes healthcare demands through unprecedented population aging [1]. This global phenomenon represents humanity's achievement of increased longevity while simultaneously presenting complex challenges for sustainable healthcare delivery. Contemporary aging populations exhibit distinctive health characteristics, with multimorbidity becoming a defining feature of modern eldercare challenges.

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Epidemiological studies demonstrate that approximately 75% of elderly individuals in China manage two or more chronic health conditions simultaneously [2]. This complexity extends beyond traditional cardiovascular and metabolic disorders to encompass neurological conditions, cognitive impairments, and functional disabilities that collectively create intricate care requirements. Healthcare systems designed for acute care delivery struggle to accommodate the chronic, complex, and continuous care requirements of multimorbid elderly populations.

Family caregivers, constituting the primary support system for multimorbid elderly individuals, experience unprecedented levels of physical, emotional, and financial strain. Research utilizing standardized burden assessment tools demonstrates that over 60% of family caregivers experience moderate to severe burden levels [3]. Healthcare delivery systems exhibit significant fragmentation, with specialists managing individual conditions in isolation rather than addressing patients holistically.

Smart aging represents a paradigmatic shift leveraging advanced technological capabilities to enhance care quality, efficiency, and accessibility [4]. This approach integrates Internet of Things devices, artificial intelligence algorithms, big data analytics, and virtual reality applications to create comprehensive care ecosystems. China's Smart Health and Eldercare Industry Development Action Plan (2021-2025) demonstrates governmental recognition of technology's potential to address aging-related challenges [5].

2. Theoretical framework

2.1. Multimorbidity characteristics in elderly populations

Multimorbidity encompasses complex clinical phenomena extending beyond simple disease coexistence to include intricate interactions between multiple pathological processes, treatment regimens, and functional impacts. Contemporary geriatric medicine recognizes multimorbidity as two or more chronic conditions persisting beyond one year, yet this definition fails to capture the dynamic, progressive nature of chronic disease interactions.

Clinical presentations exhibit significant heterogeneity influenced by genetic predisposition, environmental exposures, socioeconomic status, and healthcare access patterns. Common combinations include cardiovascular disease with diabetes mellitus, chronic obstructive pulmonary disease with heart failure, and cognitive impairment with mobility disorders [6]. These combinations create synergistic effects where managing one condition impacts others' progression and treatment.

Healthcare utilization patterns among multimorbid elderly patients reveal traditional care models' inadequacy designed for single-condition management. These individuals frequently require multiple specialist services, leading to fragmented care coordination, medication conflicts, and increased healthcare costs. The complexity of managing multiple treatment regimens often overwhelms patients and caregivers, resulting in poor adherence and suboptimal outcomes.

2.2. Care burden assessment framework

Care burden encompasses multidimensional impacts of caregiving responsibilities on family members providing support to elderly individuals with multimorbidity. This burden manifests across physical, emotional, social, and economic domains, creating complex challenges requiring systematic assessment and targeted interventions.

The Zarit Burden Interview (ZBI) represents the gold standard for care burden assessment, providing validated measurements across multiple dimensions [3]. The comprehensive 22-item

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version evaluates time demands, financial strain, physical fatigue, and emotional distress. Scoring interpretation follows established thresholds: 0-21 indicates minimal burden, 21-40 suggests mild to moderate burden, 41-60 represents moderate to severe burden, and scores exceeding 60 indicate severe burden requiring immediate intervention.

Contemporary research emphasizes bidirectional relationships between care burden and patient outcomes, demonstrating that caregiver wellbeing directly impacts care quality provided to elderly patients. High burden levels correlate with increased patient hospitalization rates, emergency department visits, and accelerated functional decline, highlighting caregiver support importance as comprehensive patient care components.

2.3. Smart aging technology architecture

Smart aging technology systems represent sophisticated integration of multiple technological domains enhancing eldercare delivery through continuous monitoring, predictive analytics, and personalized interventions. The architecture encompasses interconnected layers collectively enabling comprehensive care support.

Advanced wearable devices equipped with multiple sensors enable continuous physiological, behavioral, and environmental data collection [7]. These devices monitor vital signs including heart rate variability, blood pressure patterns, and sleep architecture while tracking physical activity levels, medication adherence, and environmental factors. Integration of tri-axial accelerometers, gyroscopes, and magnetometers provides detailed movement analysis detecting fall risks and activity pattern changes [8].

Machine learning algorithms analyze complex data patterns identifying health trends, predicting adverse events, and recommending personalized interventions [9]. Deep learning models process multimodal data streams developing comprehensive health profiles enabling predictive modeling and early warning systems [10]. Virtual reality technologies provide innovative approaches for cognitive rehabilitation, physical therapy, and social engagement [11]. These environments enable safe practice of daily living activities and cognitive training exercises.

3. Primary challenges in contemporary care management models

3.1. Current state of caregiver burden

Family caregivers, who provide essential support and medical assistance to individuals with cancer, disabilities, injuries, or chronic conditions in domestic and community environments, face substantial challenges that extend beyond their available resources and capabilities. This situation places them at heightened risk for adverse health outcomes, financial strain, and psychological impacts including burden, anxiety, depression, and emotional distress [12]. Consequently, family caregivers serving as primary providers of long-term care for elderly individuals with multiple chronic conditions encounter intensifying care pressures across various dimensions.

The unequal distribution of healthcare resources compounds these challenges significantly. Elderly populations with multimorbidity residing in remote or rural locations experience considerably restricted access to medical resources compared to those in developed areas, with notably reduced efficiency and convenience in obtaining necessary care. This disparity creates variations in the perceived value and support available to caregivers across different geographic regions when addressing similar care requirements, thereby amplifying the overall burden of care provision.

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3.2. Limitations in current management approaches

While technological advances in elderly care have emerged within the framework of smart aging initiatives, the existing management model for elderly patients with multimorbidity exhibits three fundamental systemic limitations that impede the successful implementation of integrated care strategies.

3.2.1. Information isolation and data system fragmentation

Healthcare information remains confined within separate systems across hospitals, community health facilities, and home care environments, creating significant barriers to information sharing. Electronic health records (EHRs) in tertiary care facilities frequently lack integration with data from home-based monitoring devices or primary care clinic records, resulting in incomplete clinical documentation. This fragmentation necessitates repeated data collection by caregivers and medical personnel, delays diagnostic processes, and elevates the risk of medication interactions for patients with multiple chronic conditions who typically manage 5-7 medications daily—a particularly concerning issue.

3.2.2. Absence of individualized intervention approaches

The standardized care model fails to accommodate the considerable diversity present within elderly multimorbid populations. Current interventions predominantly utilize standardized protocols designed for single conditions (such as hypertension or diabetes management) rather than developing comprehensive care strategies that address individual disease combinations, functional capabilities, and living circumstances.

For instance, an elderly individual presenting with hypertension, mild cognitive decline, and mobility restrictions requires concurrent blood pressure monitoring, cognitive enhancement activities, and fall prevention interventions. However, existing systems typically address these needs through disconnected and poorly coordinated services, which not only fail to meet patients' individualized requirements but also increase care burdens and result in inefficient resource utilization.

3.2.3. Digital accessibility gaps and technology adaptation challenges

The digital divide intensifies disparities in accessing smart elderly care services, with this resource gap being particularly evident between developed and remote regions. Elderly patients with multimorbidity in developed areas may possess greater capacity to overcome digital barriers compared to those in remote locations due to enhanced resource availability. Even within developed regions, cognitive impairments can create "concealed digital barriers," making it challenging for elderly individuals to effectively utilize complex wearable technologies.

Research examining digital literacy among elderly multimorbid populations and their caregivers reveals that technology proficiency among individuals over 60 in China demonstrates distinct hierarchical patterns. Community-based studies in Beijing indicate that elderly individuals possess limited understanding of digital literacy concepts while acknowledging their significance and expressing strong motivation to learn. Their digital capabilities exhibit a pattern of "basic familiarity with limited advanced functionality," with 49.01% capable only of simple device operation and low proficiency in complex functions, correlating with age, educational background, and economic circumstances. They encounter digital obstacles including technical operation difficulties, cognitive

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adaptation challenges, and insufficient psychological and social support, primarily depending on family assistance with inadequate community and specialized training resources [13].

The digital divide becomes more pronounced among patients with neurodegenerative conditions. Only 4% of individuals with Parkinson's disease or mild cognitive impairment (MCI) can independently operate smartwatches with complex interfaces. Primary obstacles include: reduced touchscreen accuracy due to tremors, difficulty retaining multi-step procedures due to diminished executive functioning, and challenges comprehending interface terminology. Such technological incompatibility has resulted in 82% of families discontinuing intelligent monitoring devices in favor of conventional care approaches [14]. This technological barrier undermines the effectiveness of smart devices and diminishes their potential to reduce care burdens and optimize resource distribution.

4. Strategic solutions for comprehensive elderly care

Addressing the complex challenges in elderly care requires a multifaceted approach that combines cutting-edge technology, streamlined management frameworks, and individualized service delivery. The development of an intelligent, integrated care ecosystem specifically designed for elderly populations with multiple chronic conditions represents a transformative solution.

4.1. Technology-driven solutions: enhanced monitoring and targeted interventions

4.1.1. Advanced real-time monitoring infrastructure

The implementation of sophisticated Internet of Things (IoT) monitoring systems represents a cornerstone of modern elderly care. These systems utilize intelligent wearable devices, including fall-detection bracelets with integrated accelerometers and environmental sensors capable of tracking physiological indicators and daily activities. Data transmission occurs through secure digital networks to cloud-based platforms, where advanced analytics and machine learning algorithms process information to identify patterns and anomalies.

The system's predictive capabilities enable early detection of potential health complications through subtle behavioral changes, such as altered gait patterns that may indicate impending mobility issues. This proactive approach facilitates graduated alert systems that notify family members and healthcare providers, enabling timely medical intervention and emergency preparedness.

4.1.2. Immersive technologies for cognitive and physical rehabilitation

Virtual and augmented reality technologies offer innovative pathways for therapeutic intervention and cognitive enhancement. These immersive platforms support the development of customized rehabilitation programs targeting the cognitive decline and motor impairments commonly experienced by elderly individuals.

VR-based simulations, such as virtual shopping experiences or navigation exercises, can effectively enhance executive functioning and spatial awareness in individuals with mild cognitive impairment. Similarly, AR-guided physical therapy sessions can improve mobility training for patients recovering from stroke or managing arthritis-related limitations. These technologies create engaging, controlled environments that stimulate cognitive processes while addressing physical rehabilitation needs, potentially reducing depressive symptoms and improving overall quality of life through personalized therapeutic interventions [15].

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4.2. Integrated management framework

4.2.1. Comprehensive care network development

The establishment of a "Medical-Care-Nursing Integration with Smart Technology Support" represents a revolutionary closed-loop care system. This framework creates seamless connectivity between hospital settings, community health facilities, and home-based care environments. Primary hospitals maintain responsibility for acute care management and comprehensive treatment planning, while community centers focus on ongoing monitoring and rehabilitation services. Smart technology integration enables continuous remote oversight, complemented by personalized family-based care delivery.

A centralized health information platform, built on federated learning principles and blockchain security protocols, ensures data privacy while integrating diverse information sources including electronic medical records, wearable device metrics, and caregiver assessments. This comprehensive data integration generates dynamic health risk assessments that inform prioritized intervention strategies, such as medication adjustments based on renal function changes and activity level modifications.

4.2.2. Enhanced multidisciplinary collaboration

The implementation of specialized Multidisciplinary Teams (MDT) comprising chronic disease specialists, nursing professionals, pharmacists, nutritionists, mental health counselors, and social service coordinators creates a comprehensive care approach. Smart platform technology facilitates real-time collaboration, enabling consultation and care plan modifications without geographical or temporal constraints while addressing caregiver stress and physical challenges.

This collaborative model allows specialists to identify synergistic treatment opportunities across multiple conditions, while nutritionists can develop meal plans accommodating complex dietary requirements such as diabetes management combined with dysphagia considerations. The multidisciplinary approach significantly reduces care burden while improving patient outcomes through coordinated, comprehensive care delivery.

4.3. Participatory care models: caregiver empowerment and digital inclusion

4.3.1. Digital literacy enhancement programs

Comprehensive digital literacy initiatives target both elderly patients and their caregivers, focusing on fundamental smart device operation, data interpretation skills, and basic medical application usage. These programs bridge the digital divide through community-based educational initiatives that accommodate varying learning capabilities and paces.

Partnership development with educational institutions and volunteer organizations provides individualized guidance for high-risk populations, particularly those with cognitive impairments or mobility limitations. These targeted interventions ensure equitable access to technology-enhanced care solutions.

4.3.2. Community-based collaborative care systems

The development of family-community partnership mechanisms includes the establishment of neighborhood "care support centers" staffed by professional nurses and trained volunteers. These

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facilities provide essential services including equipment maintenance, emergency caregiver support, and group counseling services to address emotional stress and burden. Implementation through pilot programs in selected regions allows for practical evaluation and refinement before broader deployment, ensuring evidence-based expansion of these innovative care models.

5. Conclusion and future directions

The complex landscape of elderly care for patients with multimorbidity presents both significant challenges and unprecedented opportunities for healthcare transformation. This research has demonstrated that traditional care models are inadequate to address the multifaceted needs of aging populations, with family caregivers bearing disproportionate burdens that compromise both patient outcomes and caregiver wellbeing.

The evidence presented throughout this study underscores three critical findings that shape our understanding of optimal care delivery for elderly patients with multiple chronic conditions. First, the fragmentation of healthcare information systems creates substantial barriers to coordinated care, resulting in inefficient resource utilization and increased caregiver strain. Second, the standardized approach to chronic disease management fails to accommodate the heterogeneous needs of multimorbid elderly populations, leading to suboptimal therapeutic outcomes. Third, digital accessibility gaps perpetuate healthcare disparities, particularly affecting vulnerable populations in remote areas and those with cognitive impairments.

The proposed integrated care framework represents a paradigm shift toward comprehensive, technology-enhanced service delivery that addresses these fundamental limitations. The "Medical-Care-Nursing Integration with Smart Technology Support" model provides a blueprint for sustainable care transformation through several key innovations. Advanced monitoring technologies enable continuous health assessment and early intervention, potentially reducing emergency hospitalizations and improving quality of life. Immersive rehabilitation technologies offer personalized therapeutic approaches that address both cognitive and physical health needs. Most importantly, the multidisciplinary collaboration framework ensures that care delivery remains patient-centered while supporting caregiver wellbeing through systematic burden reduction strategies.

Implementation of these solutions requires coordinated efforts across multiple stakeholders, including healthcare institutions, technology providers, educational organizations, and community support networks. The success of smart aging initiatives depends fundamentally on addressing digital literacy gaps through comprehensive educational programs and ensuring equitable access to technological resources across diverse populations.

Future research directions should focus on several critical areas to advance the field of elderly care management. Longitudinal studies examining the long-term effectiveness of integrated care models will provide essential evidence for policy development and resource allocation decisions. Investigation of cost-effectiveness analyses comparing traditional care approaches with technology-enhanced models will inform healthcare financing strategies. Additionally, research exploring cultural adaptation of smart aging technologies across diverse populations will ensure that innovations remain accessible and appropriate for varied demographic contexts.

The development of standardized protocols for digital literacy training programs represents another crucial research priority. Understanding optimal learning methodologies for elderly populations with varying cognitive abilities will enhance the effectiveness of technology adoption initiatives. Furthermore, investigation of privacy and security concerns related to continuous health

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monitoring will inform the development of ethical frameworks for data management in elderly care settings.

Healthcare policy implications of this research extend beyond individual care delivery to encompass systemic transformation requirements. The integration of smart aging technologies into existing healthcare infrastructure necessitates regulatory frameworks that ensure quality standards while promoting innovation. Professional development programs for healthcare providers must evolve to include competencies in technology-enhanced care delivery and multidisciplinary collaboration.

The ultimate goal of optimizing care management for elderly patients with multimorbidity extends beyond burden reduction to encompass the enhancement of dignity, autonomy, and quality of life for both patients and their caregivers. The solutions presented in this research offer pathways toward achieving these objectives through evidence-based, technology-enhanced approaches that respect the complexity of aging while leveraging innovative tools to address contemporary healthcare challenges.

As global populations continue to age, the urgency of implementing comprehensive care solutions becomes increasingly apparent. The framework presented in this study provides a foundation for sustainable healthcare transformation that can adapt to evolving demographic needs while maintaining focus on patient-centered, family-supported care delivery. Success in this endeavor will require continued collaboration among researchers, healthcare providers, technology developers, and policy makers to ensure that the benefits of smart aging technologies reach all segments of the elderly population, particularly those most vulnerable to care burden and health disparities.

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