

# Research Progress on the Combination of Rehabilitation Therapy and Evidence-Based Nursing in Restless Legs Syndrome Among Hemodialysis Patients

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**Abstract:** Restless legs syndrome (RLS) is a common neurological disorder in clinical practice, particularly prominent among hemodialysis patients. RLS severely impacts patients' sleep quality and mental state, exacerbating their pre-existing physical discomfort and life burden. Current pharmacological treatments often yield suboptimal results and carry numerous adverse effects. Consequently, combining evidence-based nursing with rehabilitation therapy has emerged as a promising intervention strategy. Rehabilitation therapy, a multimodal non-pharmacological treatment, aims to enhance patients' physical and psychological health, while evidence-based nursing emphasizes individualized, scientifically grounded nursing interventions. The integration of these two approaches not only alleviates RLS symptoms but also improves patients' quality of life and self-management abilities. Based on this, the paper conducts an in-depth study of the pathogenesis and clinical characteristics of RLS in hemodialysis patients and provides a detailed analysis of the combined application of rehabilitation therapy and evidence-based nursing for this condition.

**Keywords:** Hemodialysis; Restless legs syndrome; Rehabilitation therapy; Evidence-based nursing; Progress

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## 1. Introduction

Restless legs syndrome (RLS) is a common neurological disorder among hemodialysis patients, characterized by a complex pathogenesis involving multiple factors. Dopaminergic system dysfunction serves as the core pathological mechanism. Due to renal failure, abnormal dopamine (DA) metabolism in hemodialysis patients leads to impaired dopaminergic neurotransmission, triggering RLS. Iron metabolism disorders, common in hemodialysis patients,

directly impact neurological function and contribute to the occurrence of RLS<sup>[1]</sup>. Additionally, the accumulation of uremic toxins presents another significant challenge for these patients, with neurotoxicity damaging both central and peripheral nervous systems, exacerbating clinical manifestations.

Peripheral neuropathy plays a crucial role in RLS, where damage to peripheral nerves induces changes that contribute to the syndrome. Studies have demonstrated that RLS among hemodialysis patients arises from the combined effects of various factors. Investigating its pathogenesis holds significant clinical value for improving symptoms and the quality of life in affected patients.

## **2. Pathological mechanisms of restless legs syndrome in hemodialysis patients**

### **2.1. Dopaminergic system dysfunction**

RLS is a condition associated with abnormalities in the DA system. Recent studies suggest that impaired dopamine transmission is a significant cause of RLS. In hemodialysis patients, dopaminergic system abnormalities are pronounced due to the homeostatic imbalance caused by kidney failure, affecting dopamine synthesis, release, and reuptake. These disruptions not only alter dopamine levels in the synaptic cleft but also change DA receptor sensitivity and density, leading to central nervous system instability. Research by Yin *et al.*<sup>[2]</sup> indicates that changes in dopamine receptors can cause impaired neural transmission, resulting in RLS symptoms such as lower limb pain and involuntary movements. Rinaldi *et al.*<sup>[3]</sup> developed a screening questionnaire for RLS, considering patient cognition to ensure accuracy, thereby supporting effective diagnosis. Biochemical changes during hemodialysis may further exacerbate DA system dysfunction, with trace element imbalances affecting dopamine metabolic pathways. Additionally, anemia, common in hemodialysis patients, impacts dopamine production and release, worsening symptoms.

### **2.2. Iron metabolism disorders**

Iron plays a vital role in the central nervous system as a key component of neurotransmitters and in redox and energy metabolism. Dysregulated iron metabolism is a significant contributor to RLS. In hemodialysis patients, iron metabolism disorders, characterized by iron deficiency or overload, are prevalent and have profound effects on neural function. Iron deficiency reduces central iron levels, impairing the activity of tyrosine hydroxylase, a key enzyme in dopamine synthesis, thereby exacerbating RLS symptoms. Conversely, iron overload induces neurotoxicity by generating free radicals, triggering oxidative stress, and damaging neurons.

Due to kidney damage, hemodialysis patients often experience impaired iron storage and utilization mechanisms. Repeated blood purification and red blood cell damage during hemodialysis lead to iron loss or accumulation. Moreover, dietary restrictions and medications can further disrupt iron homeostasis. Guo *et al.*<sup>[4]</sup> investigated the effects of bedside aerobic exercise during dialysis on RLS symptoms, dialysis adequacy, and microinflammatory status in 91 patients with maintenance hemodialysis (MHD). Results showed that aerobic exercise improved RLS symptoms, reduced inflammation, and enhanced dialysis adequacy. Gulsah *et al.*<sup>[5]</sup> reviewed 14 studies, finding that interventions such as exercise, aromatherapy, reflexology, and massage significantly alleviate RLS. Regulating iron intake and storage is thus crucial in RLS treatment, with serum ferritin and transferrin saturation tests aiding in devising effective therapies.

### 2.3. Neurotoxicity of uremic toxins

The accumulation of uremic toxins is a major challenge in managing chronic kidney disease, with increasing recognition of their neurotoxic effects as a potential cause of RLS. Uremic toxins, including small molecules, middle molecules, and protein-bound toxins, adversely affect the nervous system. These toxins alter neuronal membrane permeability, disrupt ion channel function, and impair neural signal transmission. Shen *et al.* [6] examined the efficacy of moxibustion combined with acupoint massage in treating RLS in 80 hemodialysis patients, finding significant symptom relief and improved sleep quality.

Uremic toxins also trigger inflammatory responses and oxidative stress, exacerbating neuronal damage. Xu *et al.* [7] studied the effectiveness and safety of limb ischemic preconditioning (LIPC) in alleviating RLS symptoms in 45 MHD patients. Results showed LIPC effectively reduced symptoms, assessed using the International Restless Legs Syndrome (IRLS) and Clinical Global Impression (CGI-S) scales. Hemodialysis can only partially clear uremic toxins, with limited efficacy for large molecules and protein-bound toxins, resulting in persistent neurotoxic effects and RLS symptoms. Reducing uremic toxin levels is therefore essential for improving RLS management.

### 2.4. Peripheral neuropathy

Peripheral neuropathy, a common complication of chronic kidney disease, is closely linked to RLS. It is characterized by slowed nerve conduction, demyelination, and axonal degeneration, affecting sensory and motor nerve functions. Peripheral neuropathy is prevalent in hemodialysis patients due to metabolic abnormalities associated with chronic renal failure. Metabolite accumulation, high glucose, hyperphosphatemia, and electrolyte imbalances induce metabolic stress, damaging nerve fibers. Malnutrition and deficiencies in B vitamins, zinc, and magnesium further exacerbate peripheral nerve damage.

Peripheral neuropathy impairs neural signal transmission, manifesting as limb numbness, tingling, and discomfort—hallmark RLS symptoms. Strategies to restore peripheral nerve function include nutritional support, metabolic regulation, and neurotrophic therapy. Exercise and rehabilitation training have shown benefits in improving neural conductivity and alleviating symptoms. Liu *et al.* [8] observed that scalp acupuncture improved sleep quality and RLS symptoms in post-stroke patients, enhancing quality of life and promoting neural recovery. Yang *et al.* [9] emphasized the heightened risk of RLS among dialysis patients, noting its association with sleep disorders, anxiety, and depression, which significantly impact survival and quality of life.

### 2.5. Genetic factors and gene polymorphism

Recent studies reveal a hereditary component to RLS, with associations to specific gene polymorphisms. Family-based studies and GWAS indicate that certain genetic variations are linked to RLS susceptibility, involving pathways related to dopamine signaling, iron metabolism, and neural development and function. Matar *et al.* [10] conducted a narrative review identifying multiple influences on RLS, including genetic predisposition, dietary patterns, and vitamin deficiencies. Polymorphisms related to neurotransmitter regulation affect neural conduction and excitability, contributing to RLS. In hemodialysis patients, genetic factors combined with environmental influences such as uremic toxin accumulation exacerbate clinical manifestations.

## 3. Clinical manifestations of restless legs syndrome in hemodialysis patients

RLS is a common yet often overlooked condition in hemodialysis patients. Its clinical manifestations are complex

and varied, but most patients experience unbearable lower limb pain and an intense, uncontrollable urge to move, particularly during rest or sleep. These sensations are typically deep and nonspecific, often described as tingling, burning, or a crawling sensation akin to ants moving on the skin. Such symptoms significantly affect patients' daily lives and mental health.

Clinically, RLS symptoms worsen at night and during periods of rest, while physical activity provides temporary relief. Consequently, many patients engage in frequent nocturnal movement, resulting in sleep disturbances. This leads to daytime fatigue, difficulty concentrating, and in some cases, cognitive dysfunction. Contributing factors to RLS in hemodialysis patients include elevated serum urea nitrogen levels, disrupted iron metabolism, imbalances in trace elements, and altered nerve function. Additionally, comorbid conditions such as anemia, hyperparathyroidism, and calcium-phosphorus metabolism disorders further exacerbate the condition.

The clinical manifestations of RLS may differ before and after dialysis sessions, primarily due to the removal of toxins, changes in fluid balance, and electrolyte adjustments. Zhang<sup>[11]</sup> explored the effects of cycling exercise on RLS symptoms in uremic patients, finding that it significantly alleviated clinical symptoms.

LS not only causes physical distress but also imposes substantial psychological burdens, including anxiety, depression, and social difficulties. However, the subjective and nonspecific nature of its symptoms often results in misdiagnosis or missed diagnosis. Therefore, a comprehensive understanding of RLS, along with meticulous history-taking and physical examination, is essential for accurate diagnosis and timely treatment. Enhancing awareness and understanding of this condition can guide personalized treatment strategies, improve patient quality of life, and reduce the incidence of complications.

## **4. Application of rehabilitation therapy combined with evidence-based nursing**

### **4.1. Integration and practice of multimodal rehabilitation therapy**

The comprehensive application of multimodal rehabilitation therapy has become a key area of interest in managing RLS in hemodialysis patients. This approach emphasizes holistic interventions to alleviate symptoms effectively. Studies have shown that specific exercises and massages can significantly reduce RLS symptoms, improve blood circulation, and relieve muscle tension. Cognitive-behavioral therapy (CBT) also plays a crucial role by altering patients' perception and response to pain, helping them better cope with discomfort. Relaxation techniques such as deep breathing, meditation, and progressive muscle relaxation effectively reduce tension and alleviate symptoms.

Tonder *et al.*<sup>[12]</sup> investigated the prevalence and incidence of RLS in chronic renal failure (CRF) patients undergoing dialysis, including 50 patients on hemodialysis (HD) and 50 on peritoneal dialysis (PD). Their study revealed that 30.0% of the cohort exhibited RLS symptoms, though only 6.0% met international diagnostic criteria. Dialysis modality did not influence symptom occurrence, highlighting the importance of early intervention for CRF patients with RLS. However, interventions typically require integration with evidence-based nursing practices.

Evidence-based nursing employs a scientific framework, utilizing the best available research evidence to refine the selection and execution of rehabilitation therapies. Nurses must combine various therapeutic approaches flexibly, tailoring interventions to patients' symptoms and lifestyles. Multidisciplinary collaboration is crucial for alleviating RLS symptoms in hemodialysis patients. By involving nephrology, neurology, and psychiatry specialists, patients receive comprehensive evaluations and personalized treatment plans. Combining evidence-based nursing with pharmacological, physical, and psychological therapies can improve symptoms and enhance

quality of life.

Collaboration enables resource optimization and ensures patients receive the best outcomes. Nurses can dynamically update and adjust care plans based on individual patient needs, providing personalized support and compassion during recovery. Kit *et al.* <sup>[13]</sup> assessed the feasibility and acceptability of a 12-week yoga and educational film program for treating RLS. Participants in the yoga group attended 75-minute Iyengar yoga sessions twice weekly for four weeks, followed by weekly sessions for eight weeks (16 total classes), with 30-minute daily homework on non-class days. The educational group attended weekly 75-minute sessions over 12 weeks, covering RLS and other sleep disorders, management strategies, and complementary therapies. The study concluded that yoga and educational programs are feasible approaches for RLS management.

## **4.2. Personalized strategies for evidence-based nursing interventions**

Personalized interventions are critical for improving the efficacy of evidence-based nursing. Managing RLS in hemodialysis patients requires individualized care plans that consider the patient's unique condition, lifestyle habits, and psychological state. Since RLS symptoms and patients' perceptions vary widely, nurses should develop targeted care plans based on medical history, clinical symptoms, and daily activity patterns.

For instance, if symptoms predominantly occur at night, relaxation exercises or a warm foot bath before bedtime can alleviate the impact on sleep. For patients with anxiety or depression, increased focus on psychological counseling and CBT can optimize mental health <sup>[14]</sup>. Lifestyle modifications are another essential component of personalized education. Nurses should guide patients on appropriate dietary habits, exercise routines, and sleep hygiene—such as reducing caffeine and alcohol intake and promoting moderate daytime activity—to enhance overall health and alleviate RLS symptoms.

Implementing personalized evidence-based nursing interventions extends beyond care plan development and should be maintained throughout the care process. Kubasch *et al.* <sup>[15]</sup> explored complementary methods like acupuncture and hydrotherapy for treating RLS. Patients in the hydrotherapy group received self-administered cold knee/calf irrigation training twice daily for six weeks, while the acupressure group trained in six-point self-applied acupressure therapy once daily for six weeks. Each intervention required about 20 minutes daily. The six-week study found both methods effective in improving RLS symptoms.

Nurses must regularly evaluate treatment effectiveness and adjust plans accordingly. This dynamic adjustment mechanism ensures continuity in care and maximizes patient adherence, leading to better outcomes.

## **4.3. The role of rehabilitation therapy in improving quality of life**

Implementing rehabilitation therapy and evidence-based nursing for hemodialysis patients with RLS is crucial for improving their quality of life. This comprehensive intervention focuses not only on symptom alleviation but also on enhancing overall well-being.

Firstly, a key objective of rehabilitation therapy is to improve sleep quality. RLS is a significant cause of insomnia, which exacerbates psychological stress. Combining relaxation training, physiotherapy, and evidence-based nursing effectively enhances sleep quality, helping patients regain physical energy and improving their daytime mental state. Secondly, rehabilitation therapy significantly benefits psychological health. RLS often disrupts daily life, leading to feelings of anxiety and depression. The combination of CBT and psychological support in evidence-based nursing reduces mental stress, strengthens coping mechanisms, and promotes psychological well-being.

Weng *et al.* <sup>[16]</sup> studied the effects of systematic sleep interventions combined with emotional care on elderly patients with RLS treated at Xinghua City People's Hospital in Jiangsu Province between June 2018 and June 2020. The control group received routine care, while the study group received systematic sleep interventions and emotional care. The study found that this combined approach improved sleep disturbances and depressive symptoms in elderly RLS patients.

Rehabilitation therapy also improves daily functioning, thereby enhancing the quality of life. Individualized training and physiotherapy strengthen muscle function and flexibility, enabling better performance in daily activities. This improvement boosts patients' confidence, increases social participation, and enhances interpersonal skills.

Furthermore, improving communication between patients, caregivers, and healthcare providers optimizes treatment outcomes. Evidence-based nursing emphasizes patient and family education, fostering accurate understanding and management of RLS. This approach enhances patients' self-management abilities and adherence to treatment regimens.

In summary, rehabilitation therapy combined with evidence-based nursing provides a multi-layered support system for hemodialysis patients with RLS. It not only improves physiological symptoms but also enhances psychological and social well-being, contributing to an overall higher quality of life.

#### **4.4. Enhancing patient self-management through evidence-based nursing education**

Evidence-based nursing education is an effective strategy to improve self-management among hemodialysis patients with RLS. Health education aims to help patients understand the nature, triggers, and impact of the condition, empowering them to take an active role in managing their health.

Wang *et al.* <sup>[17]</sup> studied the effects of bundled care combined with traditional Chinese medicine (TCM) hot compresses on 70 hemodialysis patients with RLS at Dongtai Traditional Chinese Medicine Hospital between July 2022 and May 2023. Their results showed that this combined approach significantly alleviated symptoms, improved clinical outcomes, and increased patient satisfaction, forming an innovative integrated care model. Similarly, Sunwoo *et al.* <sup>[18]</sup> emphasized that RLS is influenced by lifestyle and sleep disturbances, advocating for health education and lifestyle interventions.

Evidence-based nursing education helps patients gain deeper insight into RLS, including its causes and physiological basis, reducing misconceptions and increasing their sense of control. This education must be tailored to individual needs, considering cultural background, education level, and information processing capacity. Nurses should use simple language and intuitive tools such as diagrams, videos, and role-playing to convey knowledge effectively.

The goal of evidence-based nursing education extends beyond knowledge transfer; it seeks to instigate behavioral change. Nurses guide patients in applying learned concepts, such as identifying early warning signs and adjusting lifestyle habits to alleviate symptoms. Additionally, building a robust support system for patients and their families helps them mentally prepare for long-term disease management.

Xia *et al.* <sup>[19]</sup> evaluated the clinical efficacy and safety of massage therapy in managing RLS symptoms among 369 hemodialysis patients across five studies. Massage therapy was found to effectively alleviate symptoms and severity without increasing adverse events, making it a preferred option.

Through evidence-based nursing education, patients can develop self-monitoring and adjustment skills, improving treatment adherence and overall quality of life.

## 4.5. Innovations in combining rehabilitation and evidence-based nursing

The integration of evidence-based nursing into the rehabilitation care of hemodialysis patients with RLS represents an innovative approach.

Firstly, evidence-based nursing emphasizes the development of individualized care plans. Given the variability among RLS patients, nurses need to assess their symptoms, medical history, and lifestyle habits on an individual basis to create tailored rehabilitation programs. Amrollahi *et al.* <sup>[20]</sup> investigated the effects of lavender oil aromatherapy massage on RLS severity in hemodialysis patients. In this study, 42 patients were randomized into intervention and control groups, with the intervention group receiving four weeks of lavender oil massage. Data collected via an RLS symptom survey showed that lavender oil massage could be used as a complementary therapy to alleviate RLS symptoms.

Secondly, a multidisciplinary collaborative approach is crucial. By integrating input from nephrology, neurology, and rehabilitation specialists, a comprehensive treatment plan can be developed to address multiple aspects of patients' clinical symptoms <sup>[21]</sup>. Real-time symptom monitoring and data analysis are essential components, allowing for timely adjustments to rehabilitation plans. This strategy overcomes the rigidity and passivity of traditional nursing models. Incorporating the latest research findings, such as new medications, exercise therapies, and psychological interventions, further supports the development of more scientific and effective rehabilitation methods <sup>[22]</sup>.

Lastly, evidence-based nursing emphasizes patient education and active participation. Empowering patients with knowledge about RLS enhances their understanding and self-management capabilities, enabling them to actively engage in their treatment journey. Health education plays a key role in fostering better symptom control and improving quality of life.

## 5. Conclusion

As our understanding of the pathogenesis of RLS deepens, rehabilitation therapies based on evidence-based nursing show promising prospects for hemodialysis patients. This comprehensive intervention transcends the limitations of traditional pharmacological treatments and offers new avenues to improve overall health.

Multimodal rehabilitation training significantly enhances physical function, while precise evidence-based nursing interventions ensure personalized and effective care. In practice, this combined approach not only alleviates RLS symptoms but also strengthens patients' self-management abilities, ultimately improving their quality of life.

Looking ahead, the deeper integration of evidence-based nursing and rehabilitation therapy could provide more comprehensive and lasting health benefits for hemodialysis patients with RLS.

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## Disclosure statement

The authors declare no conflict of interest.

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