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ASSESSMENT OF SLEEP DISORDERS AMONG MAINTENANCE HEMODIALYSIS PATIENTS

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ABSTRACT

Background. *Sleep disorders are among the most frequent and least recognized complications of kidney failure. Patients receiving maintenance hemodialysis (MHD) experience insomnia, restless legs syndrome (RLS), periodic limb movements, obstructive sleep apnea (OSA), excessive daytime sleepiness (EDS), and circadian disruption at rates several times higher than the general population. These conditions often coexist, are seldom assessed systematically, and are strongly linked to fatigue, depression, reduced quality of life, and possibly adverse cardiovascular and survival outcomes.*

Objective. *To summarize current knowledge on the epidemiology, pathophysiology, clinical phenotypes, determinants, consequences, assessment, and management of sleep disorders in MHD patients, and to propose a practical screening pathway and a research agenda.*

Methods / Literature Search. *A narrative review was conducted using PubMed/MEDLINE, Embase, Scopus, and the Cochrane Library for publications from 1985 to 2026, using combinations of the term's hemodialysis, end-stage kidney disease, sleep quality, insomnia, restless legs syndrome, sleep apnea, sleep-disordered breathing, daytime sleepiness, circadian rhythm, polysomnography, and quality of life. Observational studies, randomized trials, meta-analyses, guidelines, and reviews in English were considered. Reference lists of key articles were hand-searched. No formal risk-of-bias grading or quantitative pooling was undertaken.*

Main Findings. *Poor sleep quality affects roughly 50–80% of MHD patients, insomnia symptoms 45–70%, RLS 15–30%, and OSA (depending on threshold and method) 20–70%. Mechanisms are multifactorial: uremic toxins, anemia and iron deficiency, mineral–bone disorder, volume overload with rostral fluid shift, chronic inflammation, pruritus and pain, depression and anxiety, dialysis schedule and session timing, and disrupted melatonin and circadian rhythms. Most studies rely on subjective questionnaires; objective data are scarce. Evidence for treatment is limited, with small trials favoring optimization of dialysis and iron status, exercise, cognitive-behavioral therapy for insomnia (CBT-I), and gabapentinoids for RLS, while hypnotic safety in this population remains a concern.*

Conclusion. *Sleep disorders in MHD are common, multidimensional, and clinically important. Routine structured screening, phenotype-specific evaluation, and stepwise multidisciplinary management should be integrated into dialysis care. High-quality longitudinal and interventional studies with objective sleep measures are urgently needed.*

Keywords: *hemodialysis; end-stage kidney disease; sleep disorders; insomnia; restless legs syndrome; sleep apnea; excessive daytime sleepiness; circadian rhythm; quality of life*

1. INTRODUCTION

Chronic kidney disease (CKD) affects a substantial proportion of the world's population, and a growing number of people progress to kidney failure requiring kidney replacement therapy. Maintenance hemodialysis, typically delivered three times weekly in four-hour sessions, remains the dominant modality worldwide. Although survival on dialysis has improved modestly, patients continue to carry a heavy symptom burden that is often underappreciated by clinicians. Fatigue, pruritus, pain, depression, cramps, and sleep disturbance consistently rank among the symptoms patients consider most bothersome, and patients frequently rate them as more important than laboratory targets that dominate routine care. Sleep is a fundamental physiological process that regulates metabolic, immune, cardiovascular, cognitive, and emotional function. In the general population, insufficient or fragmented sleep is associated with hypertension, insulin resistance, cardiovascular events, depression, and mortality. Patients on MHD are exposed to a convergence of factors that impair sleep: the biochemical milieu of kidney failure, the physiological stress of ultrafiltration, a high prevalence of cardiovascular disease and diabetes, psychological distress, and a treatment schedule that reshapes daily routines. It is therefore unsurprising that sleep complaints are close to universal in dialysis units. Despite this, sleep disorders are rarely diagnosed or treated in dialysis practice. Reasons include time constraints, competing

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clinical priorities, patients' tendency to under-report symptoms, the perception that poor sleep is an inevitable consequence of dialysis, limited access to sleep medicine services, and the absence of standardized assessment protocols. Consequently, treatable conditions such as RLS, iron deficiency, OSA, and insomnia may persist for years. This review synthesizes the literature on sleep disorders in MHD patients. Sections 2–3 describe the evolution of the field and the epidemiology of individual disorders. Sections 4–7 address mechanisms, clinical phenotypes, risk factors, and consequences. Sections 8–9 examine assessment tools and management approaches and propose a pragmatic screening pathway. Section 10 identifies research gaps and priorities.

2. LITERATURE REVIEW

2.1 Evolution of Research on Sleep Disorders in Hemodialysis

Interest in sleep among dialysis patients emerged in the 1970s and 1980s, when early polysomnographic and questionnaire studies reported frequent complaints of insomnia, nocturnal leg movements, and daytime somnolence in patients with uremia. Kimmel and colleagues described sleep apnea in dialysis patients in 1989, and early series by Winkelman and colleagues in 1996 documented a high prevalence of RLS in end-stage kidney disease. These studies established that sleep problems were not simply incidental to chronic illness but seemed to reflect features specific to kidney failure. During the 1990s and 2000s, research shifted toward larger cohort studies using validated instruments such as the Pittsburgh Sleep Quality Index (PSQI), the Epworth Sleepiness Scale (ESS), and the International RLS Study Group (IRLSSG) criteria. Studies by Sabbatini, Merlino, Iliescu, and Mucsi and colleagues linked sleep disturbance to depression, anemia, and impaired quality of life. Parallel work by Hanly and Pierratos demonstrated that conversion to nocturnal hemodialysis reduced apnea severity, spotlighting the role of fluid and uremic factors in sleep-disordered breathing. Analyses from the Dialysis Outcomes and Practice Patterns Study (DOPPS) then connected poor sleep quality to mortality.

More recently, research has expanded to circadian biology, inflammation, wearable and actigraphic monitoring, and behavioral interventions, and observational evidence has increasingly been integrated into reviews and clinical recommendations. Nonetheless, randomized evidence remains sparse relative to the size of the problem.

2.2 Major Findings from Previous Studies

Several consistent findings emerge across decades of research:

1. **High prevalence.** Regardless of country, dialysis modality, or instrument, at least half of MHD patients report poor sleep, and prevalence exceeds that of the general population and of predialysis CKD.
2. **Coexistence.** Insomnia, RLS, OSA, and EDS overlap substantially, and more than one disorder is present in many patients.
3. **Association with mood and symptoms.** Depression, anxiety, pruritus, pain, and fatigue are consistently associated with poor sleep in both directions.
4. **Association with outcomes.** Poor sleep quality, RLS, and sleep-disordered breathing have been associated with reduced quality of life, hospitalization, cardiovascular events, and mortality, although residual confounding cannot be excluded.
5. **Modifiability.** Some contributors (anemia, iron deficiency, hyperphosphatemia, volume overload, dialysis dose and schedule, depression) are potentially reversible.

2.3 Current Evidence and Unresolved Issues

Despite the volume of publications, important issues remain unresolved. Definitions and cut-offs vary widely, complicating comparison of prevalence estimates. Most studies are cross-sectional, single-center, and reliant on self-report, so causal inference and temporal relationships are uncertain. Objective sleep assessment with polysomnography is uncommon, and the accuracy of screening questionnaires in dialysis populations, in whom symptoms such as fatigue and sleepiness have non-sleep causes, is not well established. It remains unclear whether treating sleep disorders improves hard outcomes such as cardiovascular events or survival. Finally, data from low- and middle-income countries, and on peritoneal dialysis, home hemodialysis, and older adults, are comparatively limited.

3. EPIDEMIOLOGY AND BURDEN OF SLEEP DISORDERS IN MAINTENANCE HEMODIALYSIS

3.1 Global Prevalence and Epidemiological Trends

Prevalence estimates vary with population, instrument, and diagnostic threshold, but the overall picture is consistent: sleep disorders are highly prevalent in MHD across regions. Studies from North America, Europe, the Middle East, South Asia, East Asia, and Africa report poor sleep quality in the majority of patients.

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Prevalence tends to be higher in older patients, women, those with longer dialysis vintage, and patients with depression, diabetes, or cardiovascular disease. Temporal trends are difficult to establish, since instruments and settings differ, although increased awareness and improved survival have increased the number of patients living with these disorders over time.

3.2 Poor Sleep Quality and Insomnia

Global sleep quality assessed by the PSQI (score above 5) is impaired in roughly 50–80% of MHD patients. Insomnia symptoms (difficulty initiating or maintaining sleep, early awakening) are reported by approximately 45–70%, and Sabbatini and colleagues found insomnia in more than two-thirds of a large Italian cohort. Formal insomnia disorder, requiring daytime consequences and chronicity, is less often quantified, but is likely present in a substantial subset. Kurella and colleagues and Elder and colleagues (DOPPS) found that a majority of patients reported poor or fair sleep and that trouble sleeping strongly tracked with worse health-related quality of life.

3.3 Restless Legs Syndrome and Periodic Limb Movements

RLS is around three to five times more common in MHD than in the general population. Reported prevalence using IRLSSG criteria generally ranges from 15% to 30%, with higher estimates in older reports and lower estimates in some East Asian studies. Periodic limb movements in sleep (PLMS), assessed by polysomnography, occur in a considerably larger proportion, often 40–70%, though many affected patients are asymptomatic. RLS in MHD is frequently more severe than idiopathic RLS and is associated with sleep fragmentation, depression, and, in some cohorts (for example La Manna and colleagues), higher cardiovascular risk and mortality.

3.4 Obstructive Sleep Apnea and Sleep-Disordered Breathing

Sleep-disordered breathing is highly prevalent. In the Sleep Heart Health Study comparison by Unruh and colleagues, moderate to severe sleep apnea (apnea–hypopnea index ≥15) was found in about half of ESRD patients, roughly twice the rate in matched controls. Depending on the AHI threshold, population, and test used, estimates range from about 20% to 70%. Central apnea and Cheyne–Stokes respiration also occur, particularly with heart failure. Classic symptoms such as snoring and witnessed apneas may be present, but obesity and typical risk profiles are less predictive than in the general population, and many patients with sleep apnea do not report sleepiness, leading to underdiagnosis.

3.5 Excessive Daytime Sleepiness and Circadian Disturbances

EDS (ESS >10) is reported by roughly 20–50% of MHD patients. It may result from nocturnal sleep loss, sleep-disordered breathing, PLMS, depression, medications, or postdialysis fatigue. Circadian disturbances include delayed sleep phase, fragmented sleep–wake rhythms, daytime napping (especially on dialysis days), and altered melatonin secretion. Patients dialyzed in the morning often nap in the afternoon and sleep less at night, whereas evening shifts may delay sleep onset.

Table 1. Approximate prevalence of major sleep disorders reported among maintenance hemodialysis patients

Disorder	Assessment method	Reported prevalence (approx.)	General population (approx.)	Representative sources
Poor sleep quality	PSQI > 5	50–80%	20–35%	Iliescu 2003; Merlino 2006
Insomnia symptoms	Interview / questionnaire (ISI, PSQI items)	45–70%	10–30%	Sabbatini 2002; Kurella 2005
Restless legs syndrome	IRLSSG criteria	15–30%	2–10%	Winkelman 1996; Mucsi 2005
Periodic limb movements	Polysomnography (PLMI > 15)	40–70%	4–11%	Benz 2000
Obstructive sleep apnea	PSG or portable monitoring (AHI ≥ 15)	20–70%	10–25%	Unruh 2006; Kimmel 1989
Excessive daytime sleepiness	ESS > 10	20–50%	10–20%	Merlino 2006; Ezzat 2015

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Note: Ranges are approximate and reflect heterogeneity in populations, definitions, and methods. General-population values are indicative only.

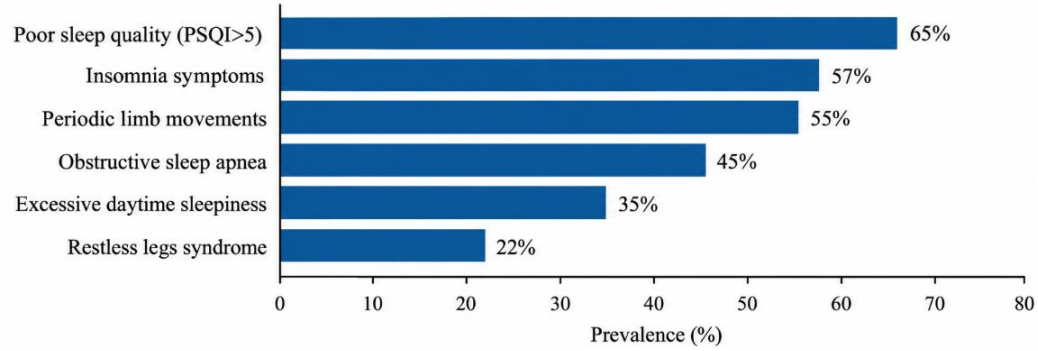

Figure 1. Comparative prevalence of major sleep disorders among maintenance hemodialysis patients (approximate midpoints of reported ranges)

4. PATHOPHYSIOLOGICAL MECHANISMS OF SLEEP DISTURBANCE

4.1 Uremic, Metabolic, Hematological, and Mineral Abnormalities

Retention of uremic toxins, including middle molecules and protein-bound solutes, is thought to alter neurotransmission and sleep architecture, and improvements in sleep after increased dialysis dose or conversion to intensive schedules support this notion. Anemia and iron deficiency are especially important: brain iron deficiency and dysregulated dopaminergic signaling are central to RLS, and intravenous iron and erythropoiesis correction improved RLS and sleep in small studies (Sloand 2004; Benz 1999). Disorders of calcium, phosphate, and parathyroid hormone have been associated with restlessness, pruritus, and sleep disruption, although results are inconsistent. Metabolic acidosis, hyperkalemia, and malnutrition–inflammation states may further contribute to fatigue and nocturnal awakenings.

4.2 Fluid Overload, Cardiovascular Dysfunction, and Respiratory Disturbances

Interdialytic volume accumulation produces peripheral edema that redistributes rostrally when patients lie down. Elias and colleagues demonstrated that the overnight rostral fluid shift correlates with neck circumference changes and AHI in ESRD, and Lyons and colleagues showed that ultrafiltration reduced apnea severity. Fluid overload, heart failure, and pulmonary congestion also promote orthopnea, periodic breathing, and central apneas. Chemoreflex sensitivity, upper-airway edema, and uremic neuromyopathy of upper-airway muscles further predispose to obstruction. Nocturnal hemodialysis and nocturnal peritoneal dialysis reduce apnea severity, implicating fluid and toxin clearance (Hanly & Pierratos 2001; Tang 2006).

4.3 Neurological, Inflammatory, and Symptom-Related Mechanisms

Uremic neuropathy, dopaminergic dysfunction, and altered iron homeostasis underlie RLS and PLMS. Chronic low-grade inflammation with elevated cytokines (interleukin-6, TNF-α, C-reactive protein) is common in MHD and may affect sleep regulation and fatigue. Pruritus, muscle cramps, bone pain, neuropathic pain, and dialysis-related symptoms disrupt sleep continuity, and pruritus is closely correlated with insomnia (Mettang & Kremer 2015). Comorbid conditions such as diabetic neuropathy, heart failure, and chronic pain add to the burden. Medications, including beta-blockers, antidepressants, and stimulants, can further modify sleep.

4.4 Psychological, Behavioral, and Circadian Mechanisms

Depression and anxiety are common in dialysis and interact bidirectionally with insomnia. Pai and colleagues found that depression and anemia were the leading correlates of poor sleep. Psychosocial stressors include loss of independence, employment, and social roles, as well as fear of mortality. Behavioral factors such as prolonged time in bed, daytime napping, inactivity, caffeine intake, and irregular routines perpetuate insomnia. Dialysis itself may influence circadian regulation: session timing, temperature and light exposure, and blunted nocturnal melatonin secretion have been described. Dialysate temperature and postdialysis body temperature changes may also modulate sleep onset.

4.5 Integrated Pathophysiological Model

The mechanisms above are not independent. Uremia, anemia, mineral disturbance, and inflammation produce neurological and dopaminergic changes; fluid overload alters airway and cardiopulmonary physiology; symptoms and psychological distress promote hyperarousal; and dialysis schedules perturb circadian regulation. The resulting sleep disturbance amplifies fatigue, inflammation, and mood symptoms, closing a vicious cycle.

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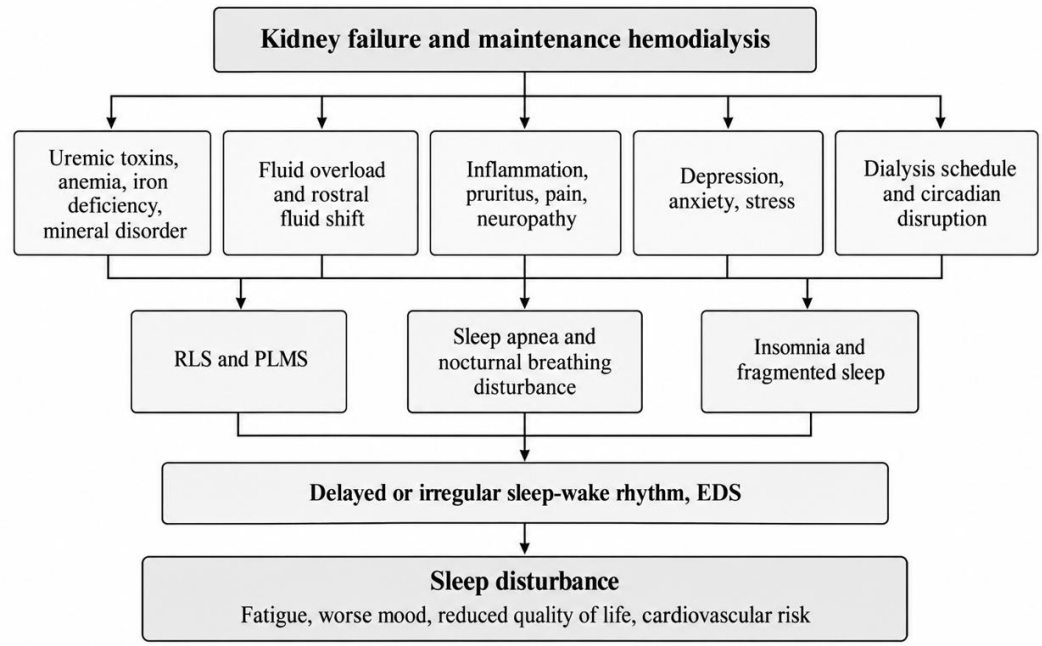

Figure 2. Integrated mechanisms linking kidney failure and maintenance hemodialysis with sleep disturbances

5. CLINICAL PHENOTYPES OF SLEEP DISORDERS IN MAINTENANCE HEMODIALYSIS

5.1 Insomnia and Poor Sleep Quality

Insomnia presents as difficulty falling asleep, frequent awakenings, early morning awakening, and non-restorative sleep, with daytime impairment. In dialysis patients, sleep-onset difficulty is commonly related to nighttime pruritus, RLS, and worry, while sleep-maintenance problems arise from pain, nocturia in patients with residual urine, and sleep apnea. Symptom patterns often differ between dialysis and non-dialysis days. Insomnia should be distinguished from sleep disturbance secondary to other disorders, since treatment of the underlying condition is often more effective than hypnotics.

5.2 Restless Legs Syndrome and Periodic Limb Movements

RLS is a clinical diagnosis based on four essential features: an urge to move the legs, usually with uncomfortable sensations; worsening at rest; relief with movement; and evening or nocturnal predominance (Allen 2014 revision). Symptoms can also appear during dialysis sessions, when patients are immobile for hours. Symptoms are commonly bilateral and may involve the arms. PLMS are stereotyped limb movements during sleep detected by polysomnography and may cause arousals; they support but do not establish an RLS diagnosis and can occur without symptoms. Uremic RLS is often severe, and augmentation may occur with dopaminergic agents.

5.3 Obstructive Sleep Apnea and Other Sleep-Disordered Breathing

OSA is characterized by repetitive upper-airway collapse during sleep with intermittent hypoxia and arousals. Typical symptoms include loud snoring, witnessed apneas, nocturnal choking, morning headaches, and sleepiness, but dialysis patients frequently lack obesity or subjective sleepiness. Central sleep apnea with Cheyne–Stokes breathing accompanies heart failure and severe fluid overload. Intradialytic hypotension, uncontrolled hypertension, arrhythmias, and refractory volume overload may signal untreated sleep-disordered breathing (Hanly & Ahmed 2014).

5.4 Excessive Daytime Sleepiness and Circadian Sleep–Wake Disturbances

EDS presents as involuntary dozing, difficulty staying awake, and reduced alertness. It should be distinguished from fatigue (lack of energy without an increased propensity to sleep) and from postdialysis recovery time, although the constructs overlap. Circadian problems include irregular sleep–wake schedules, long daytime naps, delayed sleep phase, and nocturnal wakefulness with daytime sleep, especially in shift-workers and those on evening dialysis shifts.

5.5 Overlapping and Mixed Sleep Disorders

Overlap is the rule. A patient with insomnia may have unrecognized RLS or OSA, and OSA may paradoxically manifest as insomnia. PLMS and sleep apnea both fragment sleep, and depression can be either cause or consequence. Comorbid insomnia and sleep apnea ("COMISA") is difficult to treat because CPAP intolerance

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and hyperarousal reinforce each other. Comprehensive assessment therefore requires screening for several phenotypes rather than relying on a single global sleep score.

Table 2. Clinical characteristics and distinguishing features of major sleep disorders in MHD

Disorder	Key symptoms	Distinguishing features	Typical clues in dialysis patients	Confirmatory evaluation
Insomnia	Difficulty initiating/maintaining sleep; non-restorative sleep	Daytime impairment despite adequate sleep opportunity	Pruritus, pain, depression, worry, nocturnal awakenings	Clinical interview; sleep diary; ISI
RLS / PLMS	Urge to move legs, worse at rest and evening; leg jerks in sleep	Relief by movement; response to iron/dopaminergic/gabapentinoid	Low ferritin/TSAT, symptoms during dialysis, severe course	IRLSSG criteria; PSG for PLMS
OSA	Snoring, witnessed apneas, choking, morning headache	Sleepiness may be absent; obesity not required	Refractory hypertension, volume overload, intradialytic hypotension	Overnight PSG or home sleep apnea test
Central apnea / Cheyne–Stokes	Periodic breathing, orthopnea	Associated with heart failure and severe congestion	Reduced ejection fraction, recurrent fluid overload	PSG
EDS	Dozing, low alertness	Increased sleep propensity (vs. fatigue)	Postdialysis somnolence, sedatives, nocturnal sleep loss	ESS; MSLT if narcolepsy suspected
Circadian disturbance	Irregular timing, long naps, delayed onset	Timing problem more than sleep ability	Dialysis shift, daytime napping	Sleep diary; actigraphy

6. RISK FACTORS AND DETERMINANTS

6.1 Patient-Related and Demographic Factors

Older age, female sex, and, in some studies, lower educational and socioeconomic status are associated with poorer sleep. Older patients have physiologically lighter sleep and more comorbidity, whereas women report more insomnia and RLS. Body mass index and neck circumference are associated with OSA, although less strongly than in the general population. Cultural, environmental, and housing factors (noise, shared rooms, work schedules) may influence findings across regions.

6.2 Clinical and Comorbidity-Related Factors

Diabetes mellitus, cardiovascular disease, heart failure, hypertension, chronic lung disease, neuropathy, and chronic pain are associated with worse sleep. Pruritus, cramps, and bone–mineral symptoms are strong correlates. Medications that may impair sleep include beta-blockers, corticosteroids, stimulants, and some antidepressants; antihistamines and antiemetics can trigger or worsen RLS.

6.3 Dialysis-Related Factors

Longer dialysis vintage, inadequate dialysis dose, larger interdialytic weight gains, and intradialytic hypotension have been associated with poor sleep. Session timing matters: findings differ across studies, but morning shifts commonly lead to daytime napping and evening shifts may delay sleep onset. Intradialytic sleep, dialysate temperature, and postdialysis fatigue affect nocturnal sleep. Intensive regimens (nocturnal and short daily hemodialysis) seem to improve some sleep outcomes (Hanly & Pierratos 2001; Jaber 2011), although not all sleep measures respond consistently.

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6.4 Biochemical and Treatment-Related Factors

Anemia, iron deficiency, hyperphosphatemia, hyperparathyroidism, hypoalbuminemia, elevated inflammatory markers, and hypo- or hypercalcemia have been variably linked to sleep disturbance and RLS. Because associations differ across cohorts, laboratory abnormalities should be viewed as potential contributors rather than validated predictors.

6.5 Psychological and Lifestyle Factors

Depression and anxiety are among the strongest and most consistent correlates of poor sleep. Others include perceived stress, low social support, poor coping, and cognitive arousal. Lifestyle contributors include physical inactivity, caffeine, tobacco, alcohol, daytime naps, prolonged bed rest, screen use, and irregular schedules.

Table 3. Potential risk factors associated with sleep disorders in MHD

Domain	Factor	Sleep disorder(s) most associated	Modifiable?
Demographic	Older age, female sex	Insomnia, RLS	No
Clinical	Diabetes, cardiovascular disease, heart failure	Insomnia, OSA, central apnea	Partly
Clinical	Pruritus, pain, cramps	Insomnia	Yes
Dialysis	Volume overload, large interdialytic weight gain	OSA, central apnea	Yes
Dialysis	Inadequate dialysis, session timing	Insomnia, EDS, circadian disruption	Yes
Biochemical	Anemia, iron deficiency	RLS, PLMS	Yes
Biochemical	Hyperphosphatemia, hyperparathyroidism	Insomnia, RLS (inconsistent)	Yes
Inflammatory	Elevated CRP, IL-6	Fatigue, insomnia	Partly
Psychological	Depression, anxiety, stress	Insomnia, EDS	Yes
Lifestyle	Inactivity, caffeine, daytime napping	Insomnia, circadian disruption	Yes
Pharmacological	Beta-blockers, sedatives, antihistamines, some antidepressants	Insomnia, RLS, EDS	Yes

7. CLINICAL CONSEQUENCES AND IMPACT ON QUALITY OF LIFE

7.1 Fatigue and Daytime Functioning

Fatigue affects a majority of dialysis patients and is a leading determinant of reduced function (Jhamb 2008). Poor sleep, anemia, inflammation, depression, and postdialysis recovery contribute, and the relative contribution of each varies between individuals. Sleep-related fatigue reduces participation in work, family life, and rehabilitation.

7.2 Psychological Health

Sleep disturbance and depression are tightly linked. Insomnia predicts incident depressive symptoms, and depressive symptoms worsen sleep. Anxiety, irritability, and reduced emotional resilience also occur. Because depression is associated with poor adherence and mortality in dialysis patients, sleep problems may be an important early marker and treatment target.

7.3 Cognitive and Physical Function

Sleep fragmentation and intermittent hypoxia impair attention, memory, and executive function, which are already vulnerable in kidney failure. Sleepiness increases the risk of falls, accidents, and reduced physical activity, contributing to frailty and deconditioning.

7.4 Treatment Experience and Adherence

Patients with poor sleep may experience shortened or missed sessions, difficulty adhering to fluid and diet restrictions, and reduced engagement in self-care. Intradialytic sleepiness and RLS may disrupt treatments, and nocturnal symptoms can lower tolerance of therapy. Hypnotic use is associated with adverse events in this population.

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7.5 Health-Related Quality of Life and Clinical Outcomes

Poor sleep quality independently predicts poorer physical and mental component scores. In DOPPS, Elder and colleagues found that sleep quality predicted both quality of life and mortality, and Brekke and colleagues reported similar findings in Norwegian dialysis patients. RLS has been linked with cardiovascular events and mortality (La Manna 2011), and sleep-disordered breathing with hypertension, arrhythmia, and cardiovascular disease. Since most of these data are observational, causality has not been demonstrated, but the associations justify attention.

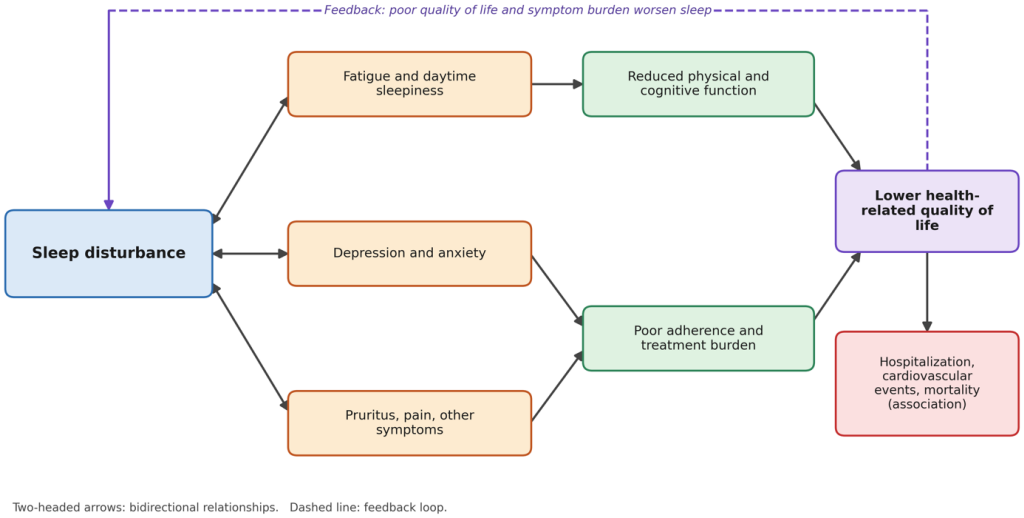

Figure 3. Bidirectional relationship between sleep disturbance, symptom burden, and quality of life

8. ASSESSMENT AND DIAGNOSTIC APPROACHES

8.1 Clinical Sleep History

A structured history is the foundation of assessment. Clinicians should ask about sleep timing, latency, awakenings, total sleep time, napping (particularly on dialysis and non-dialysis days), snoring or witnessed apneas, leg sensations, morning headaches, sleepiness while driving, medications, caffeine and alcohol, and mood. A bed partner's account improves detection of apnea and limb movements. A one- to two-week sleep diary helps differentiate insomnia from circadian problems. Review of the dialysis schedule, interdialytic weight gain, blood pressure patterns, and laboratory data (hemoglobin, ferritin, transferrin saturation, phosphate, PTH, adequacy) helps identify reversible contributors.

8.2 Validated Screening Instruments

Widely used instruments include the PSQI for global sleep quality, the Insomnia Severity Index (ISI), the ESS for sleepiness, the IRLSSG diagnostic questions and severity scale for RLS, and the STOP-Bang and Berlin questionnaires for OSA. Depression and anxiety should be screened concurrently (for example, PHQ-9 or HADS). Most instruments have been validated in general populations; their cut-offs and psychometric properties in dialysis patients are less well characterized. In particular, Berlin and STOP-Bang show only modest accuracy in MHD, and a negative screen does not exclude OSA.

8.3 Assessment of Specific Sleep Phenotypes

RLS is diagnosed clinically with the four IRLSSG criteria, after excluding mimics such as leg cramps, positional discomfort, neuropathy, and akathisia. Serum ferritin and transferrin saturation should be checked. For OSA, clinical suspicion (snoring, witnessed apneas, resistant hypertension, intradialytic hypotension, volume overload) should prompt objective testing. EDS should be quantified with the ESS and differentiated from fatigue and depression. Circadian disturbances are best assessed with diaries or actigraphy.

8.4 Objective Sleep Assessment and Polysomnography

Attended in-laboratory polysomnography remains the reference standard, permitting measurement of sleep architecture, respiratory events, oxygenation, limb movements, and arousals. Home sleep apnea testing offers a more accessible alternative for suspected OSA in patients without significant cardiopulmonary disease, and can be considered for dialysis populations, although central apnea and low sleep efficiency may reduce accuracy. Actigraphy provides estimates of sleep duration, fragmentation, and rest–activity rhythms across dialysis and non-dialysis days. Testing should ideally be performed on a non-dialysis night or with standardized timing, and recognition that results vary with volume status is important.

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8.5 Proposed Clinical Screening Pathway

A pragmatic pathway for dialysis units is:

1. **Universal screening** at initiation of dialysis and at least annually (or with clinical change) using a brief tool (for example, a PSQI or ISI item set, plus RLS and snoring/apnea questions and ESS).
2. **Review of reversible contributors:** anemia, iron status, volume status and dry weight, dialysis adequacy, mineral–bone parameters, pruritus, pain, drugs, depression.
3. **Phenotype-directed evaluation:** IRLSSG criteria for RLS; sleep study for suspected OSA or central apnea; ESS for sleepiness; sleep diary or actigraphy for circadian problems; ISI and behavioral history for insomnia.
4. **Stepwise management** as outlined in Section 9, with referral to sleep medicine, psychology, or psychiatry when required.
5. **Reassessment** after interventions to document response.

Table 4. Validated instruments used for assessment of sleep disorders in MHD

Instrument	Target	Format	Strengths	Limitations in MHD
PSQI	Global sleep quality	19 items; score 0–21 (>5 poor)	Widely used; comparable across studies	Not disorder-specific; may over-classify
ISI	Insomnia severity	7 items	Brief; sensitive to change	Limited dialysis-specific validation
ESS	Daytime sleepiness	8 items; >10 abnormal	Simple; widely used	Confounded by fatigue; poor correlate of OSA
IRLSSG criteria / severity scale	RLS diagnosis / severity	Clinical criteria; 10-item scale	Standard definitions	Mimics common (cramps, neuropathy)
STOP-Bang / Berlin	OSA risk	Brief questionnaires	Quick screening	Modest accuracy in MHD; negative results not reassuring
Sleep diary	Timing, napping, insomnia	1–2 weeks	Captures dialysis vs non-dialysis days	Requires patient effort and adherence
Actigraphy	Sleep–wake pattern	Wrist-worn device	Objective, longitudinal	Overestimates sleep; not for apnea
PSG / home sleep testing	OSA, PLMS, architecture	Overnight recording	Reference standard / accessible	Cost, access, timing relative to dialysis
PHQ-9 / HADS	Depression, anxiety	Questionnaires	Identifies key comorbidity	Somatic overlap with uremic symptoms

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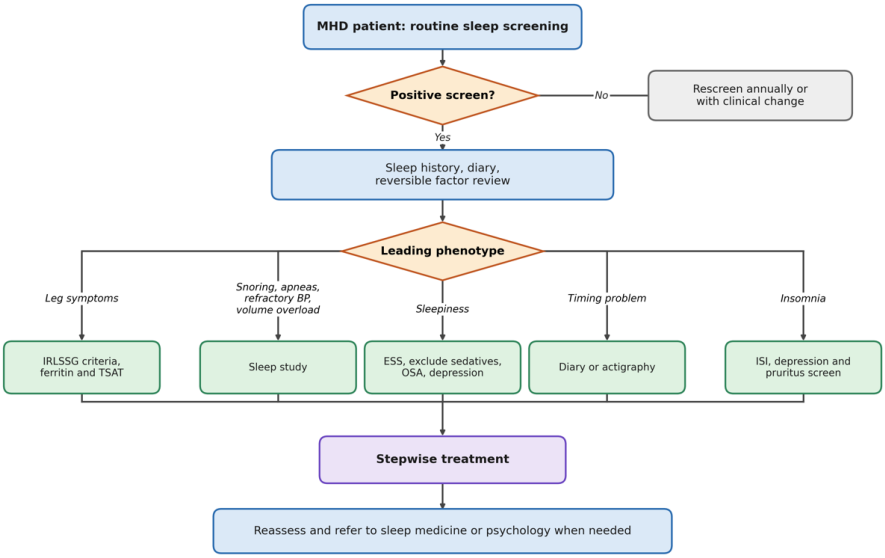

Figure 4. Suggested clinical screening and diagnostic pathway

9. MANAGEMENT AND THERAPEUTIC APPROACHES

9.1 Correction of Reversible Medical and Dialysis-Related Factors

The first step is to address contributing conditions. Optimizing dry weight and limiting interdialytic fluid gains can reduce sleep apnea and nocturnal breathlessness (Lyons 2015). Ensuring adequate dialysis dose and, where feasible, considering intensified schedules (nocturnal, short daily) may improve sleep and RLS (Hanly & Pierratos 2001; Jaber 2011). Anemia should be corrected in line with current guidelines, and iron deficiency treated: intravenous iron reduced RLS symptoms in a controlled study (Sloand 2004). Pruritus, pain, cramps, and hyperphosphatemia should be managed, and medications that worsen sleep or RLS reviewed. Depression should be identified and treated.

9.2 Non-Pharmacological Interventions

Sleep hygiene education, regular sleep–wake schedules, limiting caffeine and daytime naps, and light exposure are low-risk foundations. CBT-I is the recommended first-line treatment for chronic insomnia in the general population (Qaseem 2016) and has been adapted for dialysis patients in small trials with promising results, though evidence is limited. Intradialytic and home exercise training can reduce RLS severity and improve sleep quality. Other approaches, such as acupressure, relaxation techniques, aromatherapy, music, and mindfulness, show benefit in small, mostly low-quality studies. A Cochrane review of interventions for sleep in CKD (Natale 2019) concluded that evidence certainty was low or very low for most interventions.

9.3 Pharmacological Management

Pharmacotherapy should be used cautiously, at the lowest effective dose and for the shortest duration, given altered pharmacokinetics, polypharmacy, falls, and cognitive risks in kidney failure. Benzodiazepines and Z-drugs are associated with adverse outcomes and should generally be avoided or used briefly. Melatonin has a favorable safety profile and has shown modest benefits in small dialysis studies, including in patients with disrupted nocturnal melatonin secretion. Low-dose doxepin and other agents can be considered for sleep-maintenance insomnia guided by the general guidelines (Sateia 2017), with dose adjustment for kidney function. Sedating antihistamines and anticholinergics should be avoided. Drug choices should follow renal dosing guidance and be reviewed regularly.

9.4 Management of Specific Sleep Disorders

Insomnia: CBT-I and behavioral strategies first; treat contributors (pruritus, pain, depression); short-term pharmacotherapy only when necessary.

RLS: Check and replenish iron; remove exacerbating drugs; consider exercise and non-drug measures. For symptomatic RLS, gabapentin or pregabalin at renally adjusted doses are reasonable first-line options (Thorp 2001), and current guidelines increasingly favor alpha-2-delta ligands over dopamine agonists because of the risk of augmentation (Winkelman 2016). Dopamine agonists may be used with caution at low doses.

OSA: Volume optimization; weight management when relevant; positional therapy; continuous positive airway pressure (CPAP) as the standard for confirmed moderate to severe OSA, with adaptive servo-ventilation

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reserved for specific central apnea situations after cardiology input. Data on CPAP outcomes specifically in MHD are limited, and adherence may be challenging.

EDS: Identify and treat the cause (OSA, insufficient sleep, sedating medications, depression); schedule and behavior modification; wake-promoting agents are rarely appropriate and require specialist input.

Circadian disturbances: Fixed sleep–wake schedules, morning light exposure, limiting long naps, adjusting dialysis shift timing where feasible, and melatonin or timed light therapy for selected patients.

9.5 Multidisciplinary and Integrated Sleep Care

Effective management benefits from collaboration among nephrologists, dialysis nurses, sleep physicians, psychologists, pharmacists, dietitians, and physiotherapists. Nurse-led screening and education, protocols for referral, and integration with depression and symptom-management programs are practical models. Shared decision-making that prioritizes what patients find most burdensome improves engagement. Telehealth and digital CBT-I may extend access.

Table 5. Management strategies and level/type of supporting evidence

Strategy	Target	Evidence in MHD	Overall certainty / comments
Volume optimization / ultrafiltration	OSA, central apnea	Small physiological studies (e.g., Lyons 2015)	Low; biologically plausible
Intensified dialysis (nocturnal, short daily)	Sleep quality, apnea, RLS	Small trials, observational data	Low–moderate; limited availability
IV iron for iron deficiency	RLS	Small controlled trial (Sloand 2004)	Low–moderate
Anemia correction	Sleep, RLS, fatigue	Small early studies (Benz 1999)	Low
CBT-I	Insomnia	Small trials; strong general-population evidence	Low in MHD; recommended first-line by extrapolation
Exercise training	RLS, sleep quality	Small trials	Low
Gabapentin / pregabalin	RLS, pruritus-related sleep loss	Small trials (Thorp 2001)	Low–moderate; renal dose adjustment essential
Dopamine agonists	RLS	Limited in MHD	Low; augmentation and adverse effects
Melatonin	Sleep quality, circadian	Small trials	Low; favorable safety
Benzodiazepines / Z-drugs	Insomnia	Little safety data	Not recommended long term
CPAP	OSA	Mostly non-dialysis evidence	Low in MHD; adherence issues
Acupressure / relaxation / mindfulness	Sleep quality	Small, heterogeneous studies	Very low
Multidisciplinary care pathways	All	Emerging	Very low; pragmatic

10. RESEARCH GAPS AND FUTURE DIRECTIONS

10.1 Limitations of Current Evidence

Much of the evidence is cross-sectional, single-center, and reliant on self-report. Sample sizes are small, especially in intervention studies, and populations are heterogeneous in dialysis vintage, comorbidity, and modality. Many observational associations with mortality are vulnerable to confounding, reverse causation, and

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unmeasured factors such as depression and frailty. Publication bias and geographic imbalance (with fewer studies from low-resource settings) further limit generalizability. This review is also narrative rather than systematic, and estimates presented here are approximate.

10.2 Need for Standardized Diagnostic Approaches

Consensus is needed on which instruments and cut-offs to use in MHD, and on how to handle overlap between uremic symptoms and sleep questionnaires. Dialysis-specific validation of the PSQI, ISI, ESS, and OSA screeners, and development of brief composite tools, would improve comparability and clinical use. Core outcome sets for sleep in kidney disease, aligned with patient-prioritized outcomes, would help harmonize trials.

10.3 Objective Sleep Assessment in Dialysis Research

Polysomnography and home sleep testing are underused in dialysis research. Standardized protocols for timing relative to dialysis, volume status, and dialysis-day vs non-dialysis-day recordings are required. Wearable devices, actigraphy, and continuous monitoring of oxygenation and breathing may permit large-scale, longitudinal assessment but require validation against reference measures in this population.

10.4 Interventional and Longitudinal Research Priorities

Priorities include:

- Adequately powered randomized trials of CBT-I (including digital and nurse-delivered formats), exercise, and melatonin.
- Trials of CPAP and volume-targeted strategies with cardiovascular and patient-reported endpoints.
- Comparative trials of gabapentinoids, iron strategies, and dopaminergic agents for RLS, with attention to augmentation and safety.
- Studies of dialysis schedule and session timing, dialysate temperature, and intensive modalities on sleep.
- Longitudinal cohorts assessing whether treating sleep disorders alters cardiovascular events, hospitalization, and survival.
- Studies in peritoneal dialysis, home hemodialysis, older adults, and low- and middle-income settings.
- Mechanistic work on inflammation, uremic toxins, circadian biology, and brain iron.

10.5 Integration of Sleep Assessment into Routine Dialysis Care

Implementation research should test feasible screening workflows, staff training, referral pathways, and electronic alerts within dialysis units, and evaluate costs and effects on patient-reported outcomes. Inclusion of sleep and RLS symptoms in routine symptom-monitoring programs, alongside pain, pruritus, and depression, could ensure consistent attention.

11. CONCLUSION

Sleep disorders, including insomnia, RLS and periodic limb movements, sleep-disordered breathing, excessive daytime sleepiness, and circadian disturbances, are highly prevalent among patients on maintenance hemodialysis and are associated with substantial reductions in quality of life, mood, and possibly survival. They arise from the interplay of uremic, hematological, fluid-related, inflammatory, psychological, and dialysis-specific factors, and frequently coexist. Despite their importance, they are underdiagnosed and undertreated. A practical approach combines routine structured screening, evaluation of reversible contributors, phenotype-directed testing, and stepwise treatment that emphasizes dialysis optimization, iron repletion, behavioral therapy, and cautious pharmacotherapy within a multidisciplinary framework. Robust trials, standardized objective assessment, and implementation studies are needed to convert these recommendations into evidence-based standards of care.

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