

Sleep Apnea in Maintenance Hemodialysis: A Mixed-Methods Study



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Rationale & Objective: More than 50% of hemodialysis patients experience sleep disturbance and most have coexisting sleep apnea. However, how sleep apnea affects sleep and the overall experience of patients with chronic kidney disease treated by hemodialysis has not been evaluated.

Study Design: A mixed-methods design, incorporating cross-sectional observational and descriptive qualitative methodologies.

Setting & Participants: Patients receiving maintenance hemodialysis in Newcastle, New South Wales, Australia, with newly diagnosed sleep apnea (apnea-hypopnea index ≥ 5 per hour).

Assessments: In-laboratory polysomnography to assess sleep apnea and objective sleep parameters. Epworth Sleepiness Scale to assess daytime symptoms. A semi-structured qualitative interview to explore patient experience.

Analytical Approach: Descriptive and iterative thematic analysis.

Results: We analyzed 36 patients with newly diagnosed sleep apnea and interviewed 26 (mean age, 62 years, median apnea-hypopnea index, 32 per hour). Severity of sleep apnea did not affect

patients' sleep duration, sleep efficiency, or self-reported Epworth Sleepiness Scale score. From the qualitative interviews, 4 themes emerged: "broken sleep" related to short sleep duration, with waking and dozing off a common sleep cycle, caused by uncontrolled pain and dialysis. Many participants reported regularly "feeling unrefreshed" on waking. "Impact of sleep disturbance" included reduced physical, mental, and self-management capacity. Finally, interviewees described the need to use strategies to "soldier on" with symptoms.

Limitations: Participants' views are only transferrable to hemodialysis patients with sleep apnea.

Conclusions: Our findings suggest that severity of sleep apnea does not affect sleep time or patient-reported daytime sleepiness; however, hemodialysis patients with sleep apnea report disturbed and unrefreshed sleep and the debilitating effects of sleep disturbance is profound. Broken and unrefreshed sleep were the dominant symptoms of sleep apnea and should be assessed routinely to identify patients with sleep apnea and improve quality of life in patients with chronic kidney disease treated with hemodialysis.

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Chronic kidney disease (CKD) is a significant health concern affecting $\sim 13\%$ of adults globally.¹ Reduced kidney function adversely affects multiple organs,² in proportion to the extent of the decrease in kidney function, and it is well-recognized that people with end-stage kidney disease treated by dialysis experience a high physical and emotional burden from symptoms and impaired quality of life (QoL).³ Sleep disturbance and the consequences of poor sleep, such as fatigue and tiredness, are common symptom burdens for people receiving dialysis⁴ and contribute toward depression and impaired QoL.^{5,6}

The importance of sleep to patients with CKD was highlighted in a cross-sectional study of 100 hemodialysis patients that demonstrated that patients were more willing to increase dialysis time to improve fatigue and sleep quality than to extend life.⁷ A recent study of a consultation group involving hemodialysis patients and caregivers identified sleep as a top priority, ranked higher than mortality.⁸ Therefore, exploring factors that influence sleep and understanding how sleep disorders affect patients' lives is important for clinicians and patients to provide personalized care.

Many personal and lifestyle factors can influence sleep, such as poor sleep hygiene, psychological factors, and shiftwork.^{9,10} Medical disorders including chronic illness and specific sleep disorders also have a direct impact on the quality of sleep.¹¹ Studies have shown that the prevalence of sleep apnea in patients with CKD is as high as 80%¹²; therefore, we hypothesized that sleep apnea is one of the major contributors to sleep disturbance in hemodialysis patients. The aim of this study was to determine the symptomatic relationship between sleep apnea and sleep disturbance and explore patients' perspective of living with coexisting sleep apnea and kidney disease in those who require dialysis.

METHODS

Study Design and Participants

A mixed-methods study that combines quantitative and qualitative approaches was used to collect objective data and contextualized life experience. We invited participants who were previously enrolled in a quantitative cross-sectional study¹³ and had an abnormal apnea-hypopnea index of 5 or more per hour¹⁴ for a

qualitative interview. Inclusion criteria for the cross-sectional study were community or hospital hemodialysis patients (dialyzed ≥ 3 months, age ≥ 18 years, and understanding of written English). All participants receive thrice-weekly 4 to 5 hours of dialysis per session. Home dialysis patients, admitted inpatients, and patients who were unwilling or unable to provide informed consent were excluded.

The study was conducted according to the principles of Good Clinical Practice and all participants provided written informed consent. The qualitative component followed the criteria for reporting qualitative studies (COREQ).¹⁵ Ethical approval was granted by Hunter New England Local Health District Human Research Ethics Committee (16/09/21/4.02) and the University of Newcastle Human Research Ethics Committee (Dev-004267).

Methods of Measures

Objective Sleep

In-laboratory polysomnography was performed at John Hunter Hospital Adult Sleep Disorders and Respiratory Service. We used a type 1 device (Compumedics Ltd) that combines signals from electroencephalography, electromyography, electro-oculography, electrocardiography, and nasal airflow to monitor respiratory events and sleep stages.¹⁶ Polysomnography was conducted the night after dialysis to account for the effect of dialysis-related fluid removal on obstructive sleep apnea. Devices were fitted by a trained sleep technician and data were analyzed using validated software (Compumedics Ltd). Respiratory events and number of arousals were manually scored by a sleep researcher (G.M.P.) using the American Academy of Sleep Medicine 2017 scoring rules.¹⁷

Subjective Sleepiness

Subjective sleepiness was obtained using Epworth Sleepiness Scale, an 8-item questionnaire that assesses an individual's level of daytime sleepiness¹⁸ based on their overall experience in the prior month rather than at a single time point.

Qualitative Interviews

All interviews were conducted by the same investigator (E.P.), who had prior experience in qualitative methods. Interviews were scheduled at a time and place of the participant's choice. Interviews took place between August and September 2018. The mean duration of interviews was 18.6 (range, 10-60) minutes.

The semi-structured interviews were conducted according to a prespecified interview guide (Table S1). The interviewer also took field notes during each interview to enhance contextual understanding of transcripts. Interviews commenced with an open-ended question; follow-up questions were improvised to further explore topics that participants had raised. Reflections on the interviews were discussed

within the investigating team after the first 3 interviews, and there was no revision to the question schedule.

Data Analysis

Continuous variables are reported as mean \pm standard deviation or median and interquartile range, depending on the normality of data distribution.

Qualitative data were analyzed using an iterative thematic approach. This approach entails detailed readings of raw data to derive main concepts or themes.¹⁹ Audiofiles were transcribed verbatim and checked against the audiofile by 2 authors (G.C. and E.P.). The audio was used during analysis, and field notes and transcriptions were shared between 2 authors (G.C. and E.P.), who listened to the interviews and provided an independent perspective and interpretation. Cross-case comparison and mapping were applied to new emerging themes. To enhance the rigor of analysis, the 2 authors (G.C. and E.P.) regularly discussed each step of the analysis and themes. The summary of the themes and quotes were also reviewed by 2 other authors (V.M.M. and P.C.) independently.

RESULTS

Patient Characteristics

Sleep apnea was identified in 36 patients aged 29 to 86 years, with a mean of 65 ± 15 years. Of the 36 patients with sleep apnea, 26 agreed to interviews (Fig 1). Characteristics of interviewed patients were representative of patients with sleep apnea (Tables 1 and 2). Most displayed severe sleep apnea (median apnea-hypopnea index, 32 [interquartile range, 20.7-59.5]). Epworth Sleepiness Scale score indicated that most participants had higher than normal daytime sleepiness (mean Epworth Sleepiness Scale scores, 7.3 ± 3.7 and 6.7 ± 2.8 in all and interviewed participants, respectively), but only 7 (2 interviewed) participants had Epworth Sleepiness Scale scores higher than 10. Coexisting periodic limb movements were evident in 28% of patients with sleep apnea, and mean periodic limb movement index was 66 per hour. Only 1 interviewee was treated with a continuous positive airway pressure device for sleep apnea.

Sleep Data

We reviewed the severity of sleep apnea and apnea-hypopnea index score with both objective sleep parameters and subjective daytime symptoms. Patients with high apnea-hypopnea index scores seem to have high arousals during sleep; however, those with high apnea-hypopnea index scores did not have shorter total sleep time or reduced sleep efficiency or Epworth Sleepiness Scale scores compared with patients with low apnea-hypopnea index scores (Table 2). However, interview results indicated that most patients (70%) experienced broken sleep and

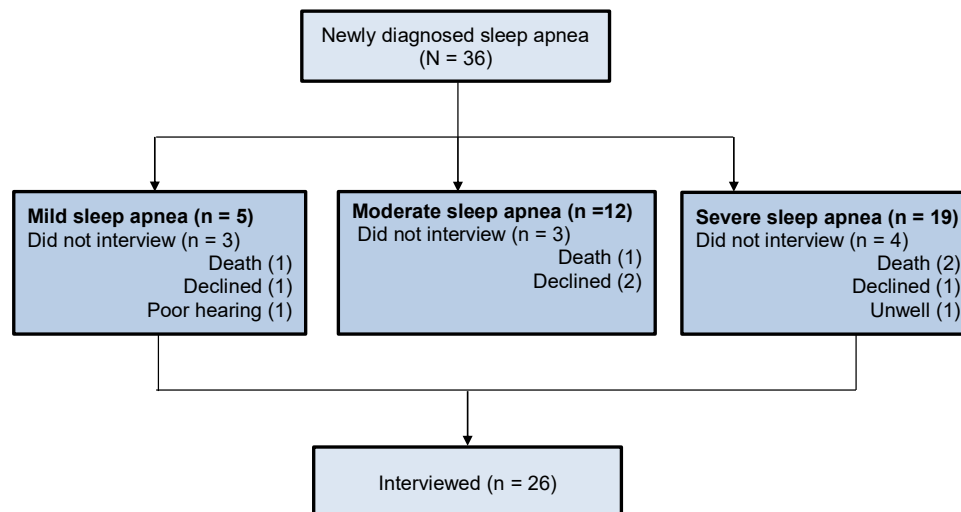


Figure 1. Recruitment flow chart for interviews.

reported feeling unrefreshed (62%) despite the small number of participants who had an Epworth Sleepiness Scale score higher than 10.

Understanding Patients' Perspectives; Major Qualitative Themes and Subthemes

There were 4 major themes that emerged from the interview data (Fig 2): broken sleep, feeling unrefreshed, impact of poor sleep quality, and soldiering on. Within each of these themes were subthemes (Fig 2). Exemplar quotes are included in the text and Tables 3 to 6. The 2 major themes of broken sleep and feeling unrefreshed were noted to be cardinal symptoms of sleep apnea²⁰ and have been mapped against the demographics and objective sleep results (Table 2) to demonstrate patient-level concordance between the quantitative and 2 major qualitative themes.

Theme 1: Broken Sleep

Interviewees described their sleep as “broken” or “interrupted,” and a cycle of sleep, wake, and dozing off was a common sleeping pattern. This pattern could be consistent and prolonged for some interviewees. On the rare occasion when sleep was uninterrupted, interviewees thought that it was due to extreme tiredness at the end of a poor sleep cycle before the next cycle started.

“I might have a really good night’s sleep...straight through uninterrupted...I think more brought on by sheer exhaustion from not getting sleep any other time...I am awake for 3 hours, sleep for 3 hours, awake for 3 hours, sleep for 3 hours, that’s what I am like all day all night.” (Woman, 60s)

Some participants were able to identify a specific factor that caused disturbed sleep. Pain and dialysis were offered as the factors associated with poor sleep.

Pain as a Sleep Disruptor. Many interviewees had uncontrolled chronic pain that caused restriction in sleep

positions and led to discomfort (Table 3). When the pain was managed or controlled, some interviewees noticed an immediate improvement in quality of sleep. For example, a man in his 70s described how he would receive a restful night sleep and not be woken up by pain when adequate analgesia was taken (Table 3).

Hemodialysis as a Sleep Disruptor. Dialysis treatment seemed to affect individuals’ sleep in different ways; some interviewees thought that it was harder to sleep after dialysis because dialysis made them more alert, whereas others felt sleepy and would often sleep during the dialysis treatment but then have sleep difficulties that evening. Postdialysis symptoms such as cramping and physical discomfort were also offered as contributors to sleep disturbance.

“Dialysis can (disturb sleep), I suppose...sometimes it’s worse on dialysis than on nondialysis nights... I think that’s because of the physical effects of dialysis, it makes it harder to feel comfortable—in like [sic], I’m not sure if that’s the right word, but yeah. Because it takes a lot out of you, you don’t feel great....” (Man, 30s).

Meeting dialysis schedules can cause stress for patients, particularly for those who maintain employment. For example, a man in his 50s, a shift worker, could often only sleep for a couple of hours before his dialysis treatment and next shift. Most interviewees had different sleep/wake routines on dialysis days (vs nondialysis days), and sleep time was usually much shorter on dialysis days because of the need to travel to dialysis centers. Early-morning dialysis appointments were another burden identified by interviewees in relation to their dialysis treatment. For example, a woman in her 40s described how her sleep on the night before dialysis was always restless because she would be constantly checking the alarm clock to ensure that she did not miss the appointment.

Table 1. Characteristics of Study Participants

	All Participants (n = 36)	Interviewed (n = 26)
Age, y	65 ± 15	62 ± 16
Sex		
Male	26 (72%)	19 (73%)
Female	10 (28%)	7 (27%)
Dialysis vintage, mo	44 ± 30	49 ± 32
Average Kt/V	1.3 ± 0.3	1.4 ± 0.3
Average interdialytic weight gain, L	2.4 ± 1.2	2.5 ± 1.3
Dialysis vascular access		
Fistula/graft	32 (89%)	24 (92%)
Central venous catheter	4 (11%)	2 (8%)
BMI, kg/m ²	32.2 ± 6.5	31.3 ± 6.7
Smoking	2 (6%)	2 (8%)
Employed	4 (11%)	3 (12%)
Work h/wk	0 [0-0]	0 [0-0]
Shift worker	2 (6%)	1 (4%)
Medication		
Opiates	3 (8%)	1 (4%)
Antipsychotics	3 (8%)	3 (12%)
Benzodiazepines	2 (6%)	1 (4%)
Comorbid Conditions		
Hypertension	22 (61%)	17 (65%)
Diabetes	20 (56%)	14 (54%)
Heart failure	14 (39%)	12 (46%)
Stroke	7 (19%)	6 (23%)
Malignancy	6 (17%)	3 (12%)
Mental health disorder	11 (31%)	10 (39%)
Sleep-Related Assessments		
ESS score	7.3 ± 3.7	6.7 ± 2.8
ESS score > 10	7 (19%)	2 (8%)
AHI, /h	32 [20.7-59.5]	32 [20.9-63.6]
Lowest Sp _o ₂	72.6 ± 14.7	73.9 ± 12.5
% time with Sp _o ₂ < 90	7.3 [2-26.1]	6.9 [2-28.4]
Snoring	28 (78%)	20 (77%)
Neck circumferences, cm	46.1 ± 5.4	45.5 ± 4.9
Sleep Architecture		
TST, min	352 ± 109	372 ± 107
Sleep efficiency, %	71 ± 18	75 ± 16
Arousals, /TST	29 ± 20	31 ± 21
Sleep latency, min	19 [5-40]	16 [5-35]
REM latency, min	122 [79-262]	130 [81-296]
NREM, % TST		
Stage 1	8 [5-22]	10 [5-25]
Stage 2	59 ± 20	58 ± 21
Stage 3 & 4	16 ± 13	16 ± 14
REM, % TST	10 ± 7	10 ± 7

Note: Categorical data expressed as mean ± standard deviation, count (percentage), or median [interquartile range] as appropriate. Abbreviations: AHI, apnea-hypopnea index; BMI, body mass index; ESS, Epworth Sleepiness Scale; NREM, nonrapid eye movement; REM, rapid eye movement; Sp_o₂, oxygen saturation as measured by pulse oximetry; TST, total sleep time.

Theme 2: Feeling Unrefreshed

Patients with coexisting kidney failure and sleep apnea reported waking unrefreshed. They described the feeling on waking as “feel/want more sleep,” “like having been

run over by a bus,” “sore,” “tired and have no energy” (Table 4). Interviewees described this symptom as bothersome because it did not change or improve regardless of the amount of sleep they had.

“(when I wake up in the morning) ... I feel like I could just go back to sleep again.... I never wake up and said [sic] oh gee I feel great.” (Man, 70s)

Theme 3: Impact of Poor Sleep Quality

The subthemes associated with the impact of poor sleep are “physical function,” “mental well-being,” “dozing off,” and “self-management” (Table 5).

Physical Function. Although fatigue is common in patients with kidney failure, almost all interviewees said their physical function was improved if they had a good sleep. Some felt an increased energy level when they slept well and would want to do more physical work, such as cleaning the house or shopping. Unfortunately, for most interviewees, poor sleep quality was a consistent theme and behavior leading to low levels of physical activity. For example, a man in his 60s described his main daily activity as sitting in front of television because this is the only activity that he could manage (Table 5). The effect of physical limitation varied; some were not bothered but others felt guilty and “useless” by being dependent on their friends or family. They described how this had a long-term effect on their mental health.

Mental Well-being. Interviewees felt “happier” and “more social” when they had a good sleep. Some even thought that they could control their mood better and were less likely to have arguments. When sleep disturbance was a long-standing issue, it posed a negative effect on self-worth. For example, one woman described the impact of a consistent cycle of poor sleep on her overall QoL.

“Very annoyed, that this is my life, this is what it gets to. This is the effect. If you could get some decent sleep, get up, and have a reasonable day, even if you could do a half of what you used to do, it would be self-rewarding. But when you can’t do anything anymore and you go this is my life and you start to feel that you’re pretty useless and it’s not nice.” (Woman, 60s)

Dozing Off. Almost every interviewee experienced unintentional dozing off; for some it was more severe and frequent than for others. Tiredness was a reason for dozing off, but some interviewees thought that the boredom, lack of social activities, and their perceived lack of purpose in life had also contributed to their tiredness and dozing. For example, a man in his 60s described his lack of social activities (due to his poor health) as the reason that he dozed (Table 5). Many interviewees believed that if there had more stimulation or tasks they needed to complete, they would be more likely to stay awake (Table 5).

Table 2. Detailed Description of Interviewees' Objective Sleep Parameters and 2 Major Symptoms From Interviews

Sex	Age, y	Living Arrangement	AHI Score	PLM, /h	ESS Score	Total Sleep, h	Sleep Efficiency, %	Arousals, /h	Broken Sleep	Feeling Unrefreshed
Male	30s	Parents	114.5	0	9	6.6	89.1	53.2	Yes	Yes
Female	40s	Son	107.7	0	12	6.3	72.8	51.6	Yes	Yes
Male	40s	Spouse	101.3	0	5	3.0	41.5	47.2	Yes	Yes
Male	70s	Nursing home	89.7	0	4	5.4	61.7	44.1	No	Yes
Male ^a	60s	Alone	89.7	0	9	8.3	92.1	97.9	No	No
Male	70s	Spouse	76.5	0	13	7.7	83.2	48.7	No	No
Male	60s	Alone	65.6	0	6	7.0	78.1	46.0	Yes	No
Male	50s	Spouse	57.5	96	7	5.1	64.6	24.2	Yes	Yes
Male ^a	80s	Alone	57	0	6	7.4	86.4	20.9	No	No
Male	70s	Spouse	50.4	113.8	5	6.8	79.4	48.8	Yes	Yes
Male ^a	70s	Alone	38.7	0	6	7.4	88.9	34.1	No	No
Female ^a	50s	Daughter	38	1.3	7	6.9	82.5	6.2	No	No
Male	50s	Spouse	34.2	172.5	8	1.5	80.3	60.4	Yes	Yes
Female	60s	Son	29.7	0	4	6.6	82.1	22.3	Yes	Yes
Male ^a	50s	Alone	29.2	0	6	7.4	94.7	23.4	No	No
Female	60s	Alone	26.4	0	7	6.5	70.8	4.4	Yes	Yes
Male	60s	Spouse	25.3	144	7	4.5	58.5	9.1	Yes	No
Female	70s	Nursing home	23.9	0	5	7.2	74.0	23.2	Yes	Yes
Male	40s	Mother	21.1	0.6	9	6.8	85.7	20.1	Yes	Yes
Female	60s	Spouse	20.8	0	9	7.9	87.7	23.4	Yes	Yes
Male	80s	Spouse	19.7	0	6	7.2	91.2	11.1	Yes	No
Male	70s	Alone	18.8	0	0	4.7	46.3	13.2	Yes	Yes
Male	80s	Spouse	16.6	0	7	2.8	37.9	29.3	Yes	Yes
Female	70s	Alone	15.2	0	9	5.5	59.8	15.1	Yes	Yes
Male ^a	20s	Alone	8.4 ^b	0	5	8.6	90.9	16.1	No	No
Male	30s	Room mate	6.9 ^b	0	2	5.6	66.2	15.7	Yes	Yes

Abbreviations: AHI, apnea-hypopnea index; ESS, Epworth Sleepiness Scale; PLM, periodic limb movement.

^aPatients with minimal symptoms (no excessive daytime sleepiness, broken sleep, and unrefreshed feeling).

^bOther clinical symptoms: snoring and chronic fatigue.

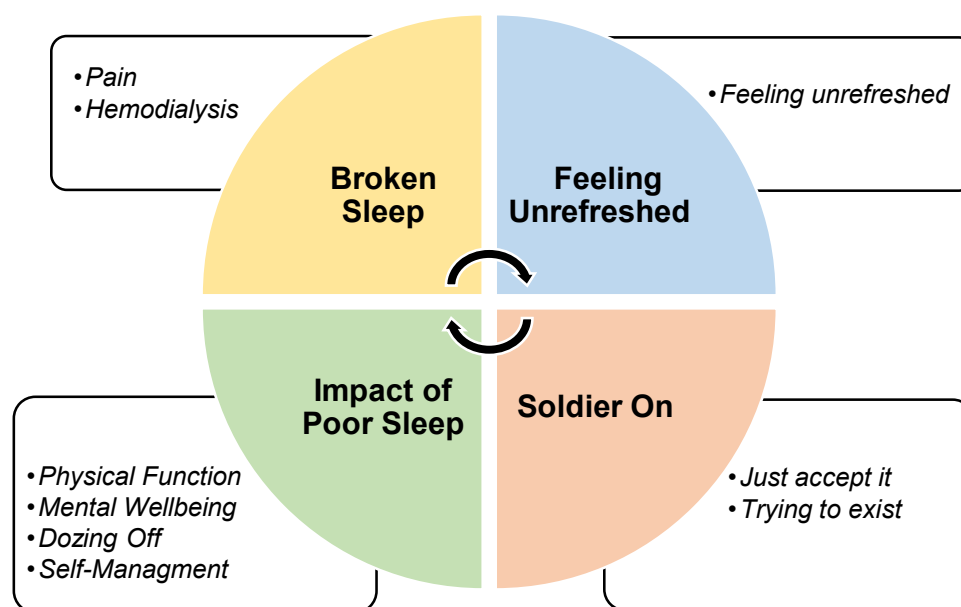


Figure 2. Themes and subthemes that emerged from the interviews.

Table 3. Interview Theme 1: Broken Sleep

Illustrative Quotes
<p>Broken Sleep</p> <p>"I'd wake up every half hour, every hour. I'd go to bed about 11 o'clock and lay there and by 12 o'clock I'd turn the TV on cause [sic] I couldn't sleep then I'd doze off with the TV on then I'd wake up an hour later." (Man, 40s)</p> <p>"It's broken sleep because I wake up during the night... I have been sleeping quite deeply last night but usually I wake up for a certain amount of time during the night." (Man, 70s)</p> <p>"I might get 2 or 3 hours at a time and then I wake up. I usually have a coffee or something or...fall asleep but then I will be up again another 2 or 3 hours or whatever, so it's all night sort of thing." (Man, 30s)</p>
<p>Pain</p> <p>"...if I don't have the morphine, I'd be awake till 2 o'clock in the morning... that is the only one that stops the pain in my stomach and let me go to sleep." (Man, 70s)</p> <p>"I have got a frozen right shoulder... so yeah if I am laying on that it will ache and wake me up..." (Man, 60s)</p> <p>"...usually discomfort, pain, can't get comfortable... I just can't move easily in bed anymore because my leg doesn't want to work properly you know... my back hurts..." (Woman, 60s)</p> <p>"...pain [wakes me up], a lot of thing [sic] it's my leg and that's from dialysis... I know it's my leg, the pain like nerve pain... I get up and walk around." (Man, 50s)</p>
<p>Hemodialysis</p> <p>"Dialysis [affect my sleep]... I don't- I can't sleep after dialysis." (Man, 70s)</p> <p>"... it [dialysis] makes me tired. I always sleep when I am on it..." (Man, 50s)</p> <p>"...dialysis day I am up at quarter to 5 to get here by 7...I just feel [tired]... that's why when I get here [dialysis] and I am on, I just try to sleep... I'm sort of alert like what time it is to get up, even though you set your alarm, you sort of question yourself did you put the alarm clock..." (Woman, 40s)</p> <p>"I finish [work] at 7 o'clock in the morning and I get to bed about half past 7 and then I am up at 12 midday because I have got to come here [dialysis] at half past 1, then I finish [dialysis] and I go straight to work." (Man, 50s)</p>

Self-management. Interviewees described how they might omit medication and/or dialysis due to a lack of sleep and tiredness. Some would often miss insulin due to accidentally dozing off or sleeping through a meal time, and some would intentionally skip dialysis treatment because of their described mental exhaustion from poor sleep.

"I'd definitely not shown up (for dialysis) if I had bad sleep, but it's not so much feeling tiredness [sic] like physical tiredness, its more mental, like not wanting to... you know when you do something repeatedly and you just get sick of it and you don't want to do it anymore." (Man, 30s)

Theme 4: Soldier On

The theme of soldier on is represented by subthemes: just accept it and trying to exist.

Just Accept It. Many interviewees believed that poor sleep was a part of their chronic disease progression and 1 of many health conditions that they had to adjust to. Being elderly and having CKD were the main reasons that some interviewees didn't expect to sleep well.

"I accept them (poor sleep) as they go. I know I can't do a lot about them, so I am not going to fight them or anything...I think it's just generally because of my health conditions and my age, I aren't [sic] young anymore." (Man, 80's)

Most interviewees had adapted well by learning to cope; but there were 2 interviewees who thought that disinterest from clinicians regarding their symptoms had forced them to eventually accept the symptom. For example, a participant described her experience of seeking medical attention for poor sleep and fatigue. She thought that clinicians were only concerned about

Table 4. Interview Theme 2: Feeling Unrefreshed

Illustrative Quotes
<p>Tired</p> <p>"I sleep quite well really, but I wake up tired..." (Woman, 70s)</p>
<p>Want to Sleep More/No Energy</p> <p>"[when I wake up in the morning] ... I feel like I could just go back to sleep again.... I never wake up and said [sic] oh gee I feel great." (Man, 70s)</p> <p>"... not tired just no energy. I'd sit in the lounge in the day and I'd fall asleep in the lounge." (Man, 40s)</p>
<p>Sore</p> <p>"... [when I wake up in the morning] I feel like I just want to go back to sleep, it's a struggle for me to get out of bed, I am really sore..." (Man, 30s)</p>
<p>Being Run Over by a Bus</p> <p>"I feel like I have been run over by a bus... I haven't felt like that [refreshed] in years but it's very rarely did [I feel refreshed]...." (Man, 40s)</p>

Table 5. Interview Theme 3: Impact of Poor Sleep Quality**Illustrative Quotes****Physical Function**

"...if I had bad night sleep tonight and I am at home tomorrow, I'll probably fall asleep after breakfast." (Woman, 40s)

"I get bit more done [when I had a good sleep] ...You know, little list going and off and running..." (Man, 50s)

"[when I had a good night sleep] ... I get up and I am more refreshed, and I get stuck into things and do things like I have- I go for a meeting with a couple of other guys...usually have coffee...and I come home and I either do some house work or something..." (Man, 60s)

"...no energy [when I had bad night's sleep], I'd do nothing, I'd get out of bed or my wife would come in and I'd go back to sleep again." (Man, 40s)

"Well when I have a good night sleep, I get up in the morning, you know, I know I got energy I have walk [sic] outside and I sweep the rubbish from the driveway and when I don't have a good energy I'm sort of walk like a zombie or something, you know?..." (Man, 60s)

"...I can hardly do nothing [sic], all sit down in bed, watch TV sometimes I just fall down to sleep you know?" (Man, 60s)

Mental Well-being

"I am not too snappy with [my partner]... we just get along. If we have a couple of words... I don't butt into it, I just let it go" (Man, 70s)

"I do honestly think [if I sleep better, get more energy], I might go around and say hi or go play bingo or something like that." (Man, 70s)

"I find if I can have a good night's sleep that I am more inclined to want to do a bit around the house." (Woman, 60s)

Dozing Off

"I might be dressed of a morning, ready to come here [dialysis], waiting for the taxi, I sit down on the chair, the next thing I'm asleep... but it all depends if I get some visitors and I get a bit of stimulation, mental stimulation, I can do lots of things..." (Woman, 70s)

"When I sit down before coming to dialysis, I have got half an hour, or three quarters of an hour and I doze off then..." (Man, 80s)

"...just slowly been talking to someone (and I start to drift off) and they go [patient's name], and I go sorry. Haha" (Woman, 60s).

"...since I have had the sleep apnea machine It's been good again, before that I was falling asleep at the drop of a hat, I'd be driving and I'd be tired as yeah." (Man, 40s)

"...sleeping in the day I think that's one part of the emotional...I can hardly do nothing [sic], all sit down in bed, watch TV sometimes I just fall down to sleep you know?" (Man, 60s)

Self-management

"I have missed having my insulin... I thought I'll just go and have a lay down about half past 5... and basically slept through till 7 o'clock this morning." (Man, 60s)

"...well, I have gone to sleep while taking my tablets..." (Woman, 60s)

"I just didn't want to take them [medication], I thought bugger them I am going to bed" (Man, 50s)

diseases that can cause direct harm or death, not things that reduce QoL, which for patients were more important.

"There's no focus on how those things (poor sleep)... I suppose if they aren't potentially going to kill you... they're just something you deal with, but yeah I think there should be more focus on how those small details can give you a better quality of life with sleeping and energy." (Woman, 60s)

Trying to Exist. People with kidney failure often have multiple comorbid conditions and severe symptom burdens that affect their QoL. Most interviewees thought that their health conditions had significantly deteriorated since commencing dialysis treatments, and despite receiving dialysis regularly, they believed that their overall health was poor. Being symptom free from pain, fatigue, and poor sleep were described by participants as more important than survival. A small number of interviewees thought that their life was not worth living, had considered ceasing dialysis, and that falling asleep is a good way to escape life.

"Well to tell you the truth I just think I sleep. I don't feel that I don't go ahhh [makes snoring noise] like this in

me [sic] sleep or nothing like that. I just sleep. Sometimes I go to sleep so I can dream. Does that sound stupid?" (Man, 70s)

DISCUSSION

We performed a mixed-methods cross-sectional study to examine the impact of sleep apnea on patients with CKD requiring maintenance hemodialysis. We found that the principle measure of sleep apnea, apnea-hypopnea index, was not directly associated with objective sleep quality or subjective daytime symptoms but was correlated with arousals. We further explored the sleep experiences of patients with CKD receiving dialysis with coexisting sleep apnea, using qualitative methodology to gain a richer understanding. Patients described profound effects of sleep disturbance on daily function, self-management of chronic illness, and overall QoL.

Heterogeneity of the clinical presentation of sleep apnea has previously been discussed in the literature, and excessive daytime sleepiness, although common, is not a universal symptom of sleep apnea.²¹ We found no association between severity of sleep apnea and sleep-related symptoms through objective sleep time and subjective excessive daytime sleepiness. Of 36 participants, only 7 (19%) reported excessive daytime sleepiness (Epworth

Table 6. Interview Theme 4: Soldier On**Illustrative Quotes****Just Accept It**

"I accept them [poor sleep] as they go. I know I can't do a lot about them, so I am not going to fight them or anything...I think it's just generally because of my health conditions and my age, I aren't [sic] young anymore." (Man, 80s)

"I just don't sleep...2-3 hours a day and I wake up...I am sitting here, my eyes are just ready to go to sleep now but I can't go to sleep....no, it doesn't worry me whether I go to sleep or I don't go to sleep, I just don't... It's just one of those things I have just got and that's it..." (Man, 70s)

"I am coping with how I am so I don't see any reason to take it further." (Woman, 60s)

"I think anyone with a kidney disease that's on dialysis, you may not wake up like you once did but I get on with it." (Man, 50s)

"I just thought it was me [tired easily], it's me yeah...I have spoken to the wife [sic] but I didn't seem to, it didn't click that's what I had [sleep apnea]. Cause I always thought yeah with sleep apnea you would have trouble sleeping and that but mine was not getting myself back to sleep most of the time." (Man, 40s)

"I think you get used to it...you have learned to just cope with it...I mean you notice it, but I think I just don't worry about it too much? It's just... I don't know if that makes any sense. It doesn't really stop me from doing anything. I never really saw it as a problem until they pointed out how bad it [sleep apnea] was." (Man, 30s)

Forced to Accept

"...I look at it as a symptom of something else so, you know, I'll say to the doctor I am very fatigued at the moment, I'm out of control fatigued but no one's jumped on it, no one's gone wonder why you're feeling this way, you know...they said it could be a heart thing but it's not the heart... see we know what happens if we have too much phosphate and calcium but what about the other things? There is no focus on who those things...I suppose if they aren't [sic] potentially going to kill you, they are just something you deal with, but I think there should be more focus on how those small details can give you a better quality of life with sleeping and energy." (Woman, 60s)

"I have been doing dialysis for 10 years and I have been going to the doctors and going to everything that I have been. I have no get up and go and you want me to do this and you want me to do that... But I am struggling to even go to work sometimes.... I have no answers you know what I mean...I have been putting up with it for 10 years..." (Man, 50s)

Trying to Exist

"If I don't have to get up and go to dialysis I wouldn't get up...you wanted to sleep more because you just want the day to finish and start again tomorrow...yes I think, I know a lot of people who sleep purely and solely for escape, they just want to sleep, they go to bed and just, put the cover over and that's where they go." (Woman, 60s)

Sleepiness Scale score ≥ 10). A prior study found that patients with CKD with sleep apnea did not commonly report excessive daytime sleepiness (mean Epworth Sleepiness Scale score, 8.8 ± 5.2) and the excessive daytime sleepiness level was no different between patients with and without sleep apnea (Epworth Sleepiness Scale scores, 8.8 ± 5.2 vs 7.3 ± 4.3 ; $P = 0.087$).²² Our data and this previous study suggest that hemodialysis patients with sleep apnea may not present with excessive daytime sleepiness and that excessive daytime sleepiness is not a good indicator to distinguish symptomatic patients.

A recent trial suggests that patients with nonexcessive daytime sleepiness sleep apnea had higher cardiovascular morbidities compared with those presented with excessive daytime sleepiness.²³ Identifying patients with nonexcessive daytime sleepiness sleep apnea therefore is clinically important, particularly in the advanced CKD population, because of the high prevalence and associated comorbid conditions that may require an individualized treatment plan.

Because quantitative measures did not reveal relevant symptoms associated with sleep apnea in patients with kidney failure, we conducted patient interviews to qualitatively explore potential symptoms and burdens. We found that although excessive daytime sleepiness was infrequently reported, hemodialysis patients with co-existing sleep apnea were not symptom free. Of 26

interviewed participants, 18 (70%) reported broken sleep and 16 (62%) experienced unrefreshed sleep on waking.

The effects of these symptoms were further elaborated by patients as an impediment to the performance of daily activities, participation in social activities, and self-care; all of which has a flow-on impact on mental health and depression. Literature supports the association between poor sleep and high symptom burden in patients receiving maintenance hemodialysis.²⁴ However, our interviewees pointed out a perceived lack of interest from clinicians to discuss their symptoms, and they wished that sleep disturbance and fatigue were treated as important health outcomes by clinicians, in the same manner as high potassium levels and fluid overload were treated.

Mismatched care priorities between patients and physicians can affect treatment outcome. There is a need for treatment priorities to be defined jointly with patients and not to be primarily focused on traditional outcomes, such as survival or hospital admission.²⁵ Our study provides novel information on patient-reported outcome measures in hemodialysis patients with co-existing sleep apnea, which could assist with the design of a fit-for-purpose kidney patient-reported outcome measures. From the qualitative interviews, we also provide new knowledge in terms of the outcomes of importance to patients.

The important clinical implication of this study is that we have observed different symptom presentations of sleep

apnea (eg. disturbed sleep vs nondisturbed sleep, excessive daytime sleepiness vs nonexcessive daytime sleepiness, and unrefreshed vs nonunrefreshed sleep) in hemodialysis patients. Given that sleep apnea is common and usually severe¹³ and symptom burden is high in patients with kidney failure,^{2,6} understanding how the disease affects patients will allow individualized strategies toward the treatment and improve symptom burdens. Furthermore, because most patients in this study with diagnosed severe obstructive sleep apnea were not treated for this condition, the need for a more systematic assessment of sleep disorders in patients with CKD receiving dialysis is recognized and recommended.

Strengths of our study include the mixed-methods approach, combining the gold-standard diagnostic tool of sleep apnea and patient interviews, and the inclusion of a broad range of participants of varying age, severity of sleep apnea, and dialysis vintage. In addition, this study to our knowledge is the first study that examines the relationship between sleep apnea and quality of sleep and the experience of patients with coexisting kidney disease and sleep apnea.

Limitations include small sample size and sampling that was focused only in patients with sleep apnea, which prevented a full understanding of sleep disturbance in all patients with advanced CKD. Nevertheless, the sample size recruited is also appropriate for a qualitative study.²⁷ We continued interviews until we achieved data saturation and hence are confident that our sample appropriately reflects the perspective of the patients interviewed.

In conclusion, we found that sleep disturbance is common and has a profound impact on health and QoL of patients with kidney failure. The conflicting message between patient interview and self-reported questionnaires indicate a need for multidisciplinary approaches and improved patient communication to truly capture the health needs of individuals. Given that the discordance in health priorities between dialysis patients and clinicians is evident,⁸ our data provide important insight into patients' experiences regarding highly reported symptoms, which is essential in informing management for patients with CKD treated by dialysis.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Table S1: Interview Guide: To Understand Sleep in Hemodialysis Patients

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