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REVIEW ARTICLE

Hypertension, Obstructive Sleep Apnea, and CPAP: A Literature Review

Tanya Doctorian* and Dennis Hwang

Department of Internal Medicine, Department of Sleep Medicine, Kaiser Permanente Fontana Medical Center, USA

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Correspondence:
Tanya Doctorian,
Department of Internal Medicine, Kaiser Permanente Fontana Medical Center, 9961 Sierra Ave. Fontana, CA 92335, USA,
Email: anya.Doctorian@kp.org

ABSTRACT

Cardiovascular Disease (CVD) is the leading cause of mortality and morbidity worldwide. Obstructive Sleep Apnea (OSA) remains an under diagnosed yet important risk factor for CVD and adverse cardiovascular out comes. There is a known link between untreated OSA and systemic hypertension, medication-resistant hypertension, and blood pressure variability. These clinical entities are independent risk factors for CVD and increased mortality. Overall, evidence suggests that Continuous Positive Airway Pressure therapy (CPAP) has a beneficial blood pressure-lowering effect in hypertensive patients who have OSA, with a more pronounced effect in those with resistant hypertension. By implementing more aggressive screening strategies and improving CPAP adherence in patients with OSA and associated co-morbidities, we can truly improve advanced clinical outcomes.

Introduction

Cardiovascular Disease (CVD) is the leading cause of morbidity and mortality worldwide [1]. Approximately 50 to 80% of patients with heart failure have Obstructive Sleep Apnea (OSA) and patients with OSA are at 2 or 3 times increased risk for CVD [2,3]. OSA is a common medical condition that affects 24% of men and 9% of middle-aged women, while the prevalence is even further increased in patients with CVD [4]. About 15 million Americans have known OSA [5]. An estimated 100 million people have OSA worldwide, but about 90% of them remain undiagnosed. While its prevalence is increasing with the obesity epidemic, OSA remains under-diagnosed and is a known risk factor for heart failure, stroke, acute coronary syndrome, a trial fibrillation, and death [6]. Continuous Positive Airway Pressure (CPAP) is the gold standard treatment for obstructive sleep apnea and can improve symptoms and quality of life in patients with concomitant OSA and CVD [3].

Hypertension is a significant risk factor for CVD and cardiovascular events, and also a preventable and treatable cause [1]. About one-third of patients with hypertension and over two-thirds of patients with medication-resistant hypertension have concomitant OSA. Hypertension is responsible for about 50% of strokes and 45% of coronary artery disease throughout the world, and is also a risk factor for heart failure, peripheral artery disease, and

chronic kidney disease [1,3,6]. Hypertension and medication-resistant hypertension increase the risk of end-organ damage and cardiovascular mortality [1,3]. Patients with resistant hypertension are 50% more likely to experience adverse cardiovascular sequelae than hypertensive patients without resistant hypertension [1,7].

In this review, we discuss the epidemiology and burden of OSA and explore its impact on hypertension. We present evidence supporting the initiation of CPAP in patients with primary hypertension, blood pressure variability, and medication-resistant hypertension—all of which are independent risk factors for the development and progression of cardiovascular disease. We discuss tools clinicians can use to predict a favorable blood pressure response in patients with medication-resistant hypertension and OSA. Additionally, we discuss implications of childhood OSA. We conclude with our recommendations on how to apply the current evidence to caring for hypertensive patients with OSA.

The Burden of Obstructive Sleep Apnea

1. Epidemiology of OSA

With the majority of the American population now obese or overweight, the prevalence of OSA and hypertension is increasing in the U.S. An estimated 77.9 million people in the United States have hypertension and about 30% of these patients have concurrent OSA, amounting to about 10-20% of the U.S. population having clinically significant OSA [1,3,5]. The prevalence of OSA is even higher in resistant hypertension, comprising over 70 to 80% of patients [7]. The Sleep Heart Health Study demonstrated that patients with moderate to severe OSA had three times higher odds of having hypertension [8]. The Wisconsin Sleep Cohort Study demonstrated a direct correlation between ambulatory Blood Pressure (BP) and Apnea-Hypopnea Index (AHI) in the absence of cofounding variables [9].

Moderate to severe OSA is associated with hypertension and other cardiovascular diseases. AHI of 15 events/hour (moderate OSA) is seen in about 30% patients with primary hypertension and up to 80% of patients with medication-resistant hypertension, 30 to 60% of patients with stroke, 60% of patients with metabolic syndrome, 40% with hypertrophic cardiomyopathy, and 12 to 15 percent of patients with systolic heart failure [10].

Obesity is a significant risk factor for the development and progression of OSA. Young et al showed that AHI was highest in patients with a BMI greater than 30, with a direct correlation between increasing BMI and severity of AHI [9]. While an elevated BMI is a risk factor for OSA, elderly patients with OSA often have a normal BMI. Male gender, excessive daytime sleepiness, alcohol, smoking, lack of exercise, are risk factors for OSA. The risk of OSA increases with age and plateaus after age of 70 years. Furthermore, hypertension, obesity, cardiovascular disease, and diabetes have a high prevalence in patients with OSA.

While the prevalence of OSA is increasing, some population studies estimate that about 85% or more patients with clinical OSA have not yet been diagnosed [11]. Women in particular are an under diagnosed group. Untreated OSA has many adverse effects in the development and progression of hypertension and cardiovascular disease and poses a significant economic and public health burden.

2. OSA and comorbidities

OSA presents a major public health burden and may have poor clinical outcomes: it increases cardiovascular risk, adversely impacts quality of life, and increases risk of progression of comorbid conditions, death, and hospital readmissions [2]. The burden of comorbidities such as heart failure and Chronic Obstructive Pulmonary Disease (COPD) leads to increased healthcare utilization and hospital readmissions, amounting to exorbitant financial ramifications [12-15]. For example, heart failure is the leading cause of hospitalization in adults over 65 years of age in the US and other developing countries, and untreated OSA is postulated to contribute to elevated readmission rate [2]. Readmission rates remain exorbitantly high; over 50% of patients are readmitted to the hospital for heart failure exacerbation within 6 months and 24% will be readmitted within 30 days [2].

There is data suggesting that CPAP adherence may potentially improve the aforementioned risks. In their prospective study, Kauta et al showed that optimal CPAP compliance in OSA patients hospitalized for cardiac conditions resulted in reduced 30-day hospital readmissions [2]. While CPAP failed to reduce death or hospitalization due to cardiovascular events in a recent randomized study (SAVE trial), subgroup analysis suggests that improved outcomes may have been seen in those with better CPAP adherence [12].

Additional data exists to suggest that adherence to positive airway pressure therapy in patients with concurrent OSA and COPD (also called overlap syndrome) may improve clinical outcomes and reduce hospital admissions [13-15]. COPD patients with AHRF will experience 80% readmission rate, 63% recurrent AHRF rate, and 49% mortality rate. Machado et al performed a 5-year prospective study, which showed that CPAP therapy in moderate to severe COPD patients with OSA experienced improved long-term survival [13]. Stanchina et al demonstrated the impact of CPAP adherence by demonstrating improved mortality in those with longer hours of nighttime CPAP use compared to those with fewer hours [14]. Konikkara et al also observed that early diagnosis and treatment of OSA in patients hospitalized for COPD exacerbation, who were adherent to CPAP therapy, experienced decreased 6-month hospital readmission rates [15]. The impact of positive airway pressure therapy may be particularly evident in those with COPD and chronic hypercapnia failure. A multi-center randomized controlled trial demonstrated that high-pressure Non-Invasive Positive Pressure Ventilation (NPPV) in chronic severe COPD patients with hypercapnia experienced a 1-year mortality rate of 12% (compared to 33% in the control group, p=0.0004) [16]. Thus, it is imperative to implement strategies to improve CPAP adherence in OSA patients, especially those with co-morbidities such as hypertension, cardiac disease, and COPD, to improve clinical outcomes and offset this global health burden.

Diagnosis of Obstructive Sleep Apnea

1. Diagnosis of OSA

OSA is characterized by upper airway obstruction, which leads to recurrent apneic and hypoapneic episodes during sleep [3]. An apnea episode is a 10-second or more pause in breathing with active respiratory effort (airway obstruction), occurring at least 5 times in an hour and resulting in oxygen desaturation. A hypopnea episode is defined as airflow less than 50% of normal, lasting 10 seconds and resulting in oxygen desaturation. OSA is defined as an AHI, which is the number of apnea and hypopnea episodes per hour during sleep, greater than 5 with concomitant symptoms of excessive daytime sleepiness [5]. AHI correlates to severity of the patient's OSA. For example, moderate OSA is defined as AHI over 15 while severe OSA is AHI over 30. In a large retrospective study, Punjabi et al demonstrated that apneas and hypopneas accompanied by oxygen desaturation of 4% or more was found to have a strong association with the presence of CVD [17]. In the patients with less than 4% oxygen desaturation, there was not a clear association between the underlying OSA and CVD.

These apneic episodes cause intermittent oxygen desaturations, which cause interruptions during sleep and daytime sleepiness [3]. Hypoxic spells and subsequent hypercapnia stimulate ventilatory effort and awakening from sleep, thereby ending the apnea or hypopnea episode. A key contributing factor to nighttime apnea and hypopnea in OSA is pharyngeal collapse from weak muscles, fluid retention, high arousal threshold, and excess neck tissue from obesity [18, 19].

The gold standard for the diagnosis of OSA is an attended in-laboratory Polysomnography (PSG) study, which includes electrocardiogram, electroencephalogram, electromyogram, pulse oximetry, airflow measurement by a nasal pressure transducer, and an oronasal thermistor [3]. Airflow is measured along with respiratory effort. In OSA, there are periods of cessation of airflow in the presence of active respiratory effort. Portable sleep study test, which includes a measurement of airflow, respiratory effort, and pulse oximetry, is a more convenient mode of diagnosing OSA, as patients can do the study in their own homes [39].

Several screening measures are in place for OSA including the Epworth Sleepiness Scale, STOP-BANG questionnaire, and the Berlin questionnaire [37,38]. Interviewing the patient's partner or spouse can also be instrumental in screening for OSA, as they may have witnessed apneic episodes while the patient sleeps.

2. Clinical manifestations of OSA

OSA typically presents as excessive daytime sleepiness, nocturnal snoring, and interrupted sleep [3]. However, in some patients, hypertension or medication-resistant hypertension can be the initial atypical presentation of OSA even in the absence of snoring or daytime sleepiness. The following section describes the pathophysiology of OSA and the mechanisms by which it leads to hypertension.

Pathophysiology of Obstructive Sleep Apnea and Hypertension

There are several proposed mechanisms by which OSA leads to hypertension and CVD.

Sympathetic pathway. Apneas and hypopneas stimulate the sympathetic nervous system and increase sympathetic tone, heart rate, and Blood Pressure (BP)—all of which increase the risk of CVD [20,21].Increased adrenergic tone in OSA patients, especially during sleep, causes increased BP variability and decreased heart rate variability, which are associated with poor outcomes [22]. In addition, diminished heart rate variability is a predictor of development of hypertension, and increased BP variability is a predictor of increased risk of hypertensive end-organ damage [23,24]. Increased sympathetic activity in patients with OSA, hypertension and heart failure leads to increased hospital readmissions from heart failure exacerbation, worsening cardiac function, and adverse clinical outcomes.

Endothelin pathway.Intermittent hypoxiaalso activates the endothelin system by causing endothelial cells to release endothelin [25]. Endothelin causes vasoconstriction, endothelial cell apoptosis and chronic intimal changes within the vessel walls, which can cause systemic vasoconstriction and hypertension [26]. Increased endothelin levels combined with increased sympathetic tone increase systemic blood pressure. In some cases, prolonged increased sympathetic tone and endothelin system activation can lead to medication-resistant hypertension and cardiovascular events [27].

Inflammatory pathway. OSA also stimulates inflammatory pathways culminating in elevated levels of inflammatory markers such as C-reactive protein, interleukin-6, tumor necrosis factor-alpha, cytokines, adhesion molecules, and increased monocyte activity [28]. Furthermore, OSA triggers oxidative stress pathways and reactive oxygen molecules [29]. OSA and sleep deprivation also increase hypercoagulability and risk of thrombosis through multiple pathways, which predisposes to CVD [30].

RAAS pathway.The aldosterone-renin system has been implicated in the pathogenesis of medication-resistant hypertension [31]. In fact, the levels of aldosterone seem to correlate with the severity of OSA [32]. Hyperaldosteronism induces increased vascular tone and causes the kidneys to retain fluid. Sanchez-de-la-Torre demonstrated increased levels of renin, aldosterone, and aldosterone-to-renin ratios in patients with concurrent OSA and medication-resistant hypertension [33]. Fluid retention in the neck (rostral) area, especially while patients are supine during sleep, is postulated to contribute to the airway obstruction that predisposes to apneic and hypopneic episodes during sleep [18,19]. In addition, fluid retention induced by hyperaldosteronism and untreated OSA can predispose heart failure patients to exacerbations.

Together, increased sympathetic tone, elevated endothelin levels, inflammatory pathway activation, and oxidative stress lead to endothelial cell dysfunction, chronic vessel wall changes—all of which culminate in hypertension.In the sections that follow, we discuss the evidence of the impact of CPAP on hypertension, blood pressure variability, and medication-resistant hypertension.

Impact of Cpap on Hypertension

1. Overview

CPAP is the gold standard treatment of OSA, and can treat nearly all cases of adult OSA. CPAP therapy

maintains the patency of the upper airway and abolishes apneic episodes, thus decreasing oxygen desaturation events, preventing sympathetic activation, and lowering endothelin levels—all of which can decrease BP in hypertension and medication-resistant hypertension. The beneficial impact of CPAP on hypertension has been established in several large trials.

2. CPAP and Arterial Stiffness

CPAP lowers BP through several mechanisms including lowering sympathetic activation, lowering endothelin levels, reducing oxidative stress. Arterial stiffness has been proposed as a marker for cardiovascular risk and mechanism of hypertension development in OSA [40,41,42]. This parameter is measured by carotid-femoral Pulse Wave Velocity (cfPWV) and Ambulatory Arterial Stiffness Index (AASI). Litvin et al performed a prospective randomized control study evaluating the impact of CPAP on patients with arterial hypertension and severe OSA (AHI over 30 events per hour) [42]. They looked primarily at vascular variables such as arterial stiffness (cfPWV, AASI). They found that the hypertensive patients with OSA treated with 3 weeks of CPAP therapy in addition to antihypertensive therapy experienced a larger reduction in ambulatory BP, office BP, central BP, and arterial stiffness compared to patients treated with antihypertensive medications (valsartan, amlodipine, and hydrochlorothiazide). Aortic, or central, systolic BP was reduced by about 4.2 mm Hg in the intervention group with even further decreases in peripheral systolic BP (31 mmHg). Several studies suggest that lowering aortic BP by as little as 3.6 mmHg decreases cardiovascular risk by 24%, reduces target organ damage, and improves prognosis [43].

Arterial stiffness is mediated by multiple mechanisms: increased sympathetic activity, elevated endothelin levels, and protein glycolation from abnormal glucose metabolism. Insulin resistance and abnormal glucose metabolism are seen in patients with OSA [42]. Chronic abnormal glucose metabolism leads to vascular inflammatory pathways, followed by proliferation and changes to the intima and media of the vessel walls, leading to arterial stiffness. CPAP prevents and can slow the progression of these pathways and can lower BP in hypertensive patients with severe OSA [42,43].

3. Variability of bp response and impact of cpap withdrawal

Blood pressure responses to CPAP therapy have been variable, which may be attributed to confounding comorbidities such as insulin resistance, hypertension, degree of daytime sleepiness, race, obesity, and increased age. Korcarz et al performed a prospective randomized clinical trial evaluating the impact of CPAP therapy on moderate-to-severe OSA in young patients who did not have baseline hypertension or other confounding comorbidities, with a focus on arterial stiffness, endothelial function, BP, and cardiac function [44]. They found that 4 and 12 weeks of compliant CPAP therapy lowered central and peripheral BP, lowered cardiac after load and arterial stiffness, and improved Left Ventricular Diastolic Function (LVDF). After 12 weeks of therapy, they evaluated the same factors after 1 week of withdrawal from CPAP. They found that after only 1 week of CPAP withdrawal, systemic BP and arterial stiffness began to reverse toward baseline, heart rate increased, and pulmonary arterial pressure began to rise on echocardiography. They also observed that the baseline severity of OSA was inversely related to the degree of improvement in LVDF with CPAP therapy.

In another study, Korcarz et al demonstrated that in heart failure patients, OSA was associated with adverse cardiac remodeling and worsening left ventricular systolic function [45]. These studies suggest that early diagnosis and treatment of OSA in the absence of confounding comorbidities can delay the development of vascular changes—arterial stiffness, sympathetic over reactivity, endothelial dysfunction—that culminate in systemic hypertension and adverse cardiac remodeling, and that even short term withdrawal from CPAP can reverse these beneficial effects.

Impact of CPAP on Blood Pressure Variability

1. Blood pressure variability and cardiovascular risk

Blood Pressure Variability (BPV), a marker of autonomic nervous system function, is the measurement of BP at

different time intervals or from visit to visit. In healthy patients, blood pressure typically fluctuates during the daytime. Patients with OSA have increased sympathetic nervous system activity, increased daytime BPV, and decreased nocturnal BPV [46]. Mokhlesi et al showed that OSA was a risk factor for nocturnal non-dipping BP and that the severity of OSA (elevated AHI) correlated to the risk of non-dipping, elevated nocturnal BP [47]. Furthermore, increased nocturnal BPV is an independent risk factor for CVD and is associated with increased morbidity and mortality in patients with CVD [48,49].

8.2. CPAP and BPV

Pengo et al studied the effect of CPAP on BPV in hypertensive and non-hypertensive patients. In their study, hypertensive patients experienced increased BPV compared to their non-hypertensive counterparts [50]. Two weeks of CPAP therapy decreased nocturnal systolic BPV and heart rate in both groups, but more significant impact was seen in the hypertensive group. This suggests that increased sympathetic activity causes increased BPV, and CPAP therapy lowers BPV by lowering sympathetic hyperactivity. Overall, this study suggests that even short term CPAP therapy can lower nocturnal BPV in OSA patients, with a significant beneficial effect in patients with concurrent OSA and hypertension. CPAP therapy in OSA patients can not only prevent and treat hypertension, but can also restore BP variability, decrease heart rate variability, and reduce risk of cardiovascular events.

Impact of Cpap on Resistant Hypertension

1. Overview

Resistant Hypertension (RH) is defined as systemic blood pressure above 140/90 mm Hgon 3 antihypertensive medications or adequate BP control (<140/90 mm Hg) on 4 or more antihypertensive medications. OSA is the most common cause of RH, comprising over 70% of patients who have RH [51]. The hypertensive population in the U.S. is steadily growing, and 12 to 27% of this population has known RH [52]. RH is a major public health and economic burden because patients with RH are at an increased risk of end-organ damage and cardiovascular complications—myocardial infarction, stroke, heart failure, hospital readmissions, and mortality—compared to hypertensive patients without RH [34,35]. In particular, patients with RH have a 20 to 25% higher risk of stroke and a 40-50% increase in hospital readmissions from heart failure compared to hypertensive patients without RH [34,35,36]. Aggressive management of hypertension and co-morbidities is needed to improve clinical outcomes in this patient group.

CPAP therapy maintains the patency of the upper airway preventing obstruction and abolishes apneic episodes, thus decreasing oxygen desaturation events, preventing sympathetic activation, lowering endothelin levels, and antagonizing the RAAS system—all of which can decrease BP in patients with OSA and medication-resistant hypertension [3,53].

Clinical Trials

There is growing data on the effect of CPAP therapy on patients with OSA and RH. Several major Randomized Control Trials (RCTs) show marked variability of BP response of CPAP therapy in patients with OSA and RH. Some RCTs demonstrate favorable BP response while others demonstrate no change or worsened BP in OSA patients with RH. Iftikhar et al performed a meta-analysis of 5 RCTs to evaluate the impact of CPAP therapy in OSA patients with RH [54]. They demonstrated a mean net decrease of 6.74 mmHg and 5.94 mmHg in ambulatory SBP and DBP, respectively. They also showed an absolute decrease of 2.08 mmHg and 1.47 mmHg in nighttime SBP and DBP, respectively. Furthermore, CPAP demonstrated a statistically significant relative decrease of 10.16 mmHg and 5.16 mmHg in ambulatory SBP and DBP compared to patients not treated with CPAP. There was also a positive correlation between hours of CPAP adherence, AHI score, and duration of RH diagnosis with blood pressure response to CPAP. In 2016, Liu et al performed a meta-analysis of 5 RCTs evaluating the impact of CPAP on RH in patients with OSA, and found overall decrease in 24-hour ambulatory systolic and diastolic BP and reduction in nocturnal DBP [55]. Collectively, CPAP therapy in patients with OSA and RH causes a decrease in both

ambulatory and nocturnal BP [56]. Thus, while multiple prospective and randomized trials have each shown discrepancies in the response of BP in patients with OSA and RH treated with CPAP, the overall data exhibits a favorable response of BP to CPAP in patients with OSA and RH.

CPAP exhibits a greater BP lowering effect in patients with OSA and RH than in hypertensive patients without RH [33]. In other words, the degree of BP-lowering effect in RH is greater than that in hypertensive patients without RH. This is clinically significant because patients with RH are at higher risk of end-organ damage and adverse cardiovascular events than patients with medication-controlled hypertension [34]. CPAP can help lower BP in RH patients on multiple antihypertensive medications and prevent adverse clinical outcomes [35].

Role of Biomarkers in Predicting a Favorable Response of BP to CPAP

Given the large degree of variability in the effect of CPAP therapy on BP levels seen in multiple prospective and randomized studies, there has been an increased interest in identifying groups of people who will benefit the most from CPAP therapy. Sanchez-de-la-Torre et al performed a multi-center randomized, control trial evaluating the impact of 3 months of CPAP treatment on BP levels of patients with concomitant OSA and RH, and looked at the role of various biomarkers in predicting a favorable versus unfavorable BP response to CPAP in patients with CPAP and RH [33]. A favorable response to CPAP was defined as reduction in mean BP greater than 4.5 mm Hg. They specifically evaluated the role of micro-Ribonucleic Acids (miRNAs) in predicting favorable response to CPAP in patients with OSA and RH. miRNAs are short non-coding RNAs which function to regulate gene expression by interacting with messenger RNA (mRNA) and impacting translation into protein synthesis or degradation of the miRNA. Some miRNAs are associated with gene regulation in the cardiovascular system [33].

They isolated 8miRNAs associated with a favorable BP response to CPAP. In the favorable BP responder group, the miRNAs—initially comprising high circulating plasma levels pre-CPAP treatment—decreased in concentration after 3 months of CPAP therapy, correlating to the mean BP decrease [33]. The BP responder group exhibited a mean 10 mm Hg decrease in systolic BP levels after 3 months of CPAP therapy. This study demonstrated the potential role of a miRNA assay as a predictive screening tool for favorable BP response in patients with OSA and RH.

Additionally, Sanchez-de-la-Torre demonstrated increased levels of renin, aldosterone, and aldosterone-to-renin ratios in both groups of patients with RH [33]. The responder group exhibited greater decreases in the aldosterone-to-renin ratio compared to the non-responder group, correlating with the decrease in mean BP measurements following CPAP adherence. Thus, CPAP can antagonize the RAAS system and significantly lower BP in patients with difficult to treat hypertension [33].

Furthermore Sanchez-de-la-Torre illustrated the role of the HIPARCO-Score in identifying patients who will respond favorably to CPAP therapy [33]. The miRNA assay and HIPARCO Score can be used to target patients with OSA and RH who will exhibit a favorable BP response from CPAP therapy.

Childhood OSA

About 3 to 12 percent of children snore, while OSA has a prevalence of 1 to 10 percent [58]. Many children outgrow mild OSA, but those who demonstrate continued OSA are at risk for multiple developmental and cardiovascular complications. While obesity has a significant impact on the prevalence of childhood OSA, there is a genetic component in the association of craniofacial abnormalities and OSA in young children.

Manifestations of OSA in childhood include snoring, mouth breathing, nighttime apnea episodes, excessive daytime sleepiness, daytime irritability, frequent nighttime awakenings, failure to thrive, poor academic performance, attention-deficit disorder, and restlessness [58-60]. Severe childhood OSA can result in pulmonary hypertension, corpulmonale and cyanosis [58]. Physical exam features include obesity, tonsillar enlargement, laryngeal abnormalities, lingual tonsils, craniofacial abnormalities, and failure to thrive. Failure to thrive is

attributed to increased work of breathing requiring increased energy expenditure, as well as decreased production of growth hormone during interrupted sleep [60,61].

Parameters to diagnose OSA in childhood are different than those in adulthood—AHI greater than 1 or a minimum oxygen saturation of less than 92% [58]. Treatment of childhood OSA includes adeno tonsillectomy, CPAP, nasal steroids, surgical correction of craniofacial abnormalities, and tracheastomy as a last resort. Early treatment of OSA in childhood can improve failure to thrive, behavior problems, and academic performance. Furthermore, early treatment can prevent cardiovascular complications.

Clinical Significance: Future Directions

OSA remains an under diagnosed yet important risk factor for CVD and adverse cardiovascular outcomes. As discussed earlier, there is a known link between untreated OSA and systemic hypertension, medication-resistant hypertension, and blood pressure variability. These clinical entities are independent risk factors for cardiovascular disease and increased mortality. Overall, evidence suggests that CPAP therapy has a beneficial BP-lowering effect in hypertensive patients who have OSA, with a more pronounced effect in patients with RH. The benefits of CPAP adherence are five-fold: 1) lowers blood pressure in hypertensive patients, 2) improves quality of life, 3) prevents progression of co-morbidities, 4) decreases hospital readmissions, and 5) decreases incidence of advanced adverse cardiovascular outcomes.

With the increasing prevalence of OSA and its risk for poor cardiovascular outcomes, it is critical to implement more aggressive screening strategies for OSA in patients diagnosed with essential hypertension and medication-resistant hypertension to correct reversible OSA and optimize blood pressure. By implementing more aggressive screening strategies and improving CPAP adherence in patients with OSA and associated co-morbidities, we can truly improve advanced clinical outcomes. Our sleep medicine center has been implementing telemedicine and mobile health technology to improve CPAP adherence and patient engagement with therapy—the outcomes are promising. Furthermore, clinicians should encourage regular follow up and adherence to CPAP therapy to maximize BP response and optimize hypertension management. By implementing aggressive screening for OSA in patients with hypertension and ensuring CPAP adherence in addition to current standard medical care, clinicians can further improve hypertension management, decrease hospital readmissions, and improve outcomes in this vulnerable patient population.

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