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Increasing Continuous Positive Airway Pressure Compliance with Various Telemedicine Interventions: An Integrated Literature Review

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Abstract

Aims and Objectives. This literature review's objective was to synthesize evidence from previously published literature on telemedicine interventions' effectiveness on CPAP (Continuous Positive Airway Pressure) therapy compliance.

Background. It is estimated that 22 million Americans suffer from a form of Sleep Apnea (SA), and those up to 80 percent of the cases of moderate to severe Obstructive Sleep Apnea (OSA) are undiagnosed (Sleep Apnea, n,d). The first-line therapy for OSA is CPAP. However, CPAP therapy is associated with low compliance rates.

Design. Systematic review.

Method. A multi-database literature search was conducted to identify published literature between 2009 and 2020. Articles were published in English, and search terms included: Continuous positive airway pressure, CPAP, CPAP therapy, CPAP compliance, telehealth, telemedicine, telephone appointments, video appointments, remote monitoring. Inclusion and exclusion criteria were identified and enacted.

Results. The literature search yielded 33 articles, and six were selected for review. Two papers were systemic reviews, and four were Randomized Control Trials. All pieces were published in 2017 or later.

Conclusions. A review of the literature suggests that utilization of telemedicine in CPAP adherence has produced favorable results. Study periods, however, were limited, with most being a year or less. Future studies that evaluate the long-term usefulness and cost-effectiveness of telemedicine interventions are needed.

Relevance to clinical practice. Telemedicine interventions are a useful tool that may be utilized to increase CPAP therapy compliance. Remote monitoring, telephone appointments, video

appointments, and communication through secured online patient portals can be used by registered nurses to effectively monitor and educate patients on the importance of therapy compliance.

Keywords. Continuous positive airway pressure, CPAP therapy, CPAP compliance, CPAP adherence, telehealth, telemedicine, telephone appointments, video appointments, remote monitoring

Introduction.

Sleep problems affect 35 – 40% of the adult population of the US (Ram, Kumar & Clark, 2010). Sleep disorders are known to have a detrimental impact on the quality of life in addition to a variety of health conditions such as hypertension, type II diabetes, heart failure, and cardiovascular disease (Bonsignore, Baiamonte, & Mazzuca, 2019). CPAP is the first-line therapy for OSA. CPAP is a highly effective treatment; however, the compliance rates with this form of treatment is low (Rotenberg, Murariu, & Pang, 2016). When CPAP therapy is followed as directed, patients can experience decreased daytime sleepiness and improvement in comorbidities. The fact remains that many patients are unable to tolerate CPAP, and compliance rates hover in the 30 - 60% range (Morgenthaler et al., 2008).

It is estimated that 22 million Americans suffer from a form of SA. Of those, up to 80 percent of the cases are moderate to severe OSA are undiagnosed (Sleep Apnea, n,d). There are several types of SA, and OSA is the most common. Patients with a diagnosis of OSA have an increased risk of cardiovascular and cerebrovascular morbidity and mortality (Jennum et al., 2015). OSA results when the muscles of the throat relax and intermittently block the airway. This condition is prevalent in 2% to 4% of middle-aged working adults (Stepnowsky et al., 2007). Signs and symptoms of OSA include but are not limited to daytime sleepiness, snoring, a sudden awaking from sleep while choking or gasping, low concentration when performing tasks, and awakening with a dry mouth and a sore throat (Aardoom et al., 2020).

The first-line therapy for OSA is CPAP. CPAP therapy delivers positive air pressure keeping the airway from collapsing. Air is dispatched through a variety of nasal and full-face masks. However, CPAP therapy is associated with low compliance rates (Rotenberg, Murariu, & Pang, 2016).

Aims

The aim of this paper is to synthesize evidence from currently available literature about CPAP therapy and the utilization of telemedicine to aid in compliance.

Methods

An online search was conducted in the following databases: CINAHL, PubMed, The Cochrane Library, Medline, and Proquest. The following search terms were used individually and in combination with each other: Continuous positive airway pressure, CPAP therapy, CPAP compliance, CPAP adherence, telehealth, telemedicine, telephone appointments, video appointments, remote monitoring. Also, the reference lists of the selected publications were checked to identify other, possibly relevant literature. Set inclusion criteria were human subjects, age 18 or older, peer-reviewed journals, English language and published between 2009 and 2020. Exclusion criteria selected were animal subjects, non-peer-reviewed studies, grey literature, papers not published in the English language, and study participants under 18. The Johns Hopkins Nursing Evidence-Based Practice Appraisal tools (Walter, 2020) were utilized to assess the strength of the evidence presented in each article.

Results

A literature review utilizing single search keyword terms resulted in published articles (Table 1). Combining keywords resulted in a manageable number of published articles to be considered (Table 2). A combination of CPAP and telemedicine and CPAP and telehealth returned the same five articles, so the duplicated items were removed. After the duplicates were removed, this left a yield of 44 articles, and after being examined for inclusion criteria, six papers were selected for review.

Terminology

Telehealth is a broad term used to describe practicing medicine using technology at a distance (American Association of Family Practioners, 2020). The provider is in one location and utilizes a telecommunications network to provide care to patients at a remote site. Examples of telehealth include but are not limited to health education services, remote monitoring, telephone appointments, video appointments, and secure messaging.

Literature Review

Six studies were analyzed and consisted of two meta-analyses and four randomized controlled trials (RCT) (Table 3). The two meta-analyses were a review of the literature and produced a robust N=5429 (Aardoom et al., 202020) and n=2464 (Chen et al., 2020) respectively. The other four studies are RCTs with study sites each in Belgium, the United States, Spain, and France. One RCT did not have CPAP compliance as their primary focus (Pépin et al., 2019); however, it was a secondary outcome. All study subjects were 18 years or older and had a diagnosis of OSA. All had either a home-based sleep study or a lab polysomnography test for diagnosis with an AHI (Apnea-Hypopnea Index) of five higher. All but one RCT took place at a single sleep medicine clinic or health center while the one RCT encompassed 32 sleep centers across a geographical area (Pépin et al., 2019).

All six studies listed their limitations, and only the meta-analyses revealed how they assessed for bias. The meta-analyses used the Cochran Collaboration risk-of-bias tool (Aardoom et al., 2020), and Chen et al. (2020) used the Cochrane Handbook of Systematic Reviews of Interventions and the Jadad Scale to evaluate all the studies selected for their review. The meta-analysis by Aardoom et al. (2020) reports that a high risk of bias was present in some studies for one or more dimensions. The care as usual (CAU) group had a wide variance that could bias the

results. Two of the studies did not meet the participant level for sufficient power, while one of the RCTs met the minimum number of participants for adequate power (Aardoom et al., 2020). When randomization was reviewed by Chen et al. (2020), studies that detailed the exact randomization method were scored at low risk for bias. For studies that did not report randomization details but stated the study design was an RCT, they were scored as there was an unclear risk of bias.

The six studies analyzed all showed that telemedicine interventions increased CPAP compliance. Non-compliance is a common problem with CPAP therapy, and it is projected that 30% - 80% of patients are non-compliant (Hoet et al., 2017). A patient is considered CPAP compliant when they have used their device a minimum of four hours and 70% of 30 nights in a consecutive 30-day timeframe (Hoet et al., 2017). The meta-analysis conducted by Aardoom et al. (2020) revealed that with telemedicine interventions, CPAP usage increased on average by 30 minutes a night. The Chen et al. (2020) meta-analysis showed an MD (Mean Difference) of TM at 0.68 h with a confidence interval of 95% compared to the care as usual group MD of .34 h. The multi-site RTC affirmed that the average CPAP usage was 5.28 hours nightly in the telemedicine group than the usual care group usage of 4.75 hours a night (Pépin et al., 2019). At the single-site RTC, the telemedicine group averaged 5.7 hours nightly versus the usual care group, with an average of 4.2 hours per night (Hoet et al., 2017). After 90 days of CPAP usage, study participants averaged 4.8 hours a night for the telemedicine group compared to the CAU group, who averaged 3.8 hours a night (Hwang et al., 2018). In addition to assessing the effectiveness of telemedicine interventions, a study by Lugo et al. (2019) also conducted a cost-effectiveness analysis to determine the financial feasibility of telemedicine interventions. They conducted a Bayesian analysis that showed a mean total cost of 557.54 € for telemedicine

interventions compared to 710.88 € for traditional face to face visits (Lugo et al., 2019). Their analysis showed a cost savings of 231.34 €, which confirmed the cost-effectiveness of telehealth interventions.

Discussion

The review of the literature revealed that telehealth interventions have a positive effect on adherence to CPAP therapy. Telehealth interventions such as remote monitoring and secure messaging were used as either an add on treatment or as a replacement to CAU. These telehealth interventions increased overall CPAP therapy adherence on average of 30 minutes per night when compared to CAU as usual alone. The review did not indicate significant differences between telehealth supplementation to CAU and telehealth as a replacement to CAU.

The expansive scope of telehealth interventions has a positive impact on CPAP therapy compliance in adults with OSA diagnosis. These telehealth interventions can help distribute standardized education to patients, closely monitor their CPAP data daily, and assist with the early identification of problems and nonadherence to therapy. Early detection leads to prompt and reasonable response even at a distance. The impact of early detection of non-compliance may diminish the number of follow-up appointments to clinics and allows for the patient to get the interventions they need when they need them. These telemedicine interventions increase access to care for patients.

This literature review has also shown that telehealth interventions increase adherence to CPAP therapy, which has a practical impact on a range of health conditions such as reduced blood pressure, decreased daytime sleepiness, improved sleep quality, and an overall increase in self-perceived wellness. The best way to gain the full benefits of CPAP therapy is through patient compliance and continued use.

The response that the patient will have to any therapy is never certain. Patients can and will have varying clinical signs and symptoms and how CPAP adherence impacts these. This literature review revealed no accepted cut-off point, which determines how much compliance leads to improvement. Response to treatment will vary. Some patients may experience improvement with fewer hours utilizing CPAP therapy, whereas others may not notice any improvement with prolonged CPAP usage.

Adults are not the only patient population who can suffer from OSA. Children under age 18 can be diagnosed with OSA and receive CPAP therapy based on sleep study results. The focus of this literature review was on the adult population. Studies to evaluate the long-term implications of telemedicine interventions have not been conducted as of yet. Long term implications of these interventions are an area that needs additional study.

Conclusion

Based on the evidence review, telemedicine can be a powerful tool to increase CPAP compliance in adults with OSA. Increased CPAP usage is associated with overall better health outcomes and improved quality of life. On therapy reports, patients complain about waking from sleep feeling more refreshed with more energy throughout the day. Concentration is improved, and productivity at work increases. CPAP therapy improves mood and can reduce the symptoms of depression.

There are, however, knowledge gaps that remain. The studies reviewed covered a relatively short period that did not extend past the initial 24 months. Further research is needed to evaluate the long-term effects of telemedicine interventions on CPAP compliance. It would be interesting to see the compliance rate for patients who utilize telemedicine for a 2 – 5-year period. The cost-effectiveness of this type of telehealth interventions should also be studied.

Initially, the focus could be on the short-term, but the long-term should cost should also be included. Does the telemedicine intervention need to be provider driven? Can a registered nurse or a respiratory therapist perform these interventions with patients? How practical are online applications such as Airview OSA treatment? These are other areas of study that should be examined.

Relevance to Clinical Practice

Telemedicine interventions are a useful tool to increase CPAP therapy compliance. Remote monitoring, telephone appointments, video appointments, and communication through secured online patient portals can be used by registered nurses to effectively monitor and educate patients on the importance of therapy compliance.

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Table 1

Table 1. Literature search results by single keyword

Keyword	Article Yield
CPAP	4495
CPAP Therapy	637
CPAP Compliance	168
CPAP Adherence	261
Telemedicine	18,924
Telehealth	18,819
Telephone appointments	174
Video appointments	47
Remote Monitoring	1334

Table 2

Table 2. Literature search results by combined keywords

Combined Keywords	Article Yield
CPAP and Telemedicine	33
CPAP and Remote Monitoring	4
CPAP Compliance and Telemedicine	5
CPAP Compliance and Remote Monitoring	2

Table 3

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Variables Studied and Their Definitions	Measurement	Data Analysis	Findings	Appraisal: Worth to Practice (Johns Hopkins Evidence Appraisal Research Tool Rating)
Aardoom et al., 2020	None	Systematic review	*n* = 5,429	CPAP: continuous positive airway pressure CAU: care as usual	Increase in average use per night of CPAP.	Cochrane Collaboration risk of bias tool Random effects model	CPAP compliance increased on average of 30 minutes per night when eHealth interventions were utilized, when compared to care as usual alone.	**Strengths:** Cochrane SR highest level of evidence **Limitations:** Limited to adult population Moderate to high heterogenicity Variance in care as usual **Critical Appraisal Rating:** IA
Chen et al., 2020	None	Systematic review	*n* = 2,464	TM: tele-monitoring SPT: supervised PAP titration HAPT: home auto-adjusting	CPAP compliance is higher in TM group when compared to CAU group, with mean difference of 0.68 hrs.	Mean deviation Odds ratios w/ 95% confidence interval Fixed-effect model	TM care is correlated to greater CPAP compliance when compared to CAU.	**Strengths:** Meta-analysis **Limitations:** Follow-up time varied in each study HAPT limited to patients with AHI > 30

				pressure titration AHI: apnea hypoxia index		Random effects model Funnel plots		**Critical Appraisal Rating:** IA
Hoet et al., 2017	None	RCT	*n* = 46	CPAP: continuous positive airway pressure TM: tele-monitoring UC: usual care	TM group had better compliance compared to UC group at 3 months 5.7 h/night vs 4.2 h/night *p* = 0.018.	Mann-Whitney U unpaired test Bland-Atlman analysis	TM is associated with increasing compliance at 3 months.	**Strengths:** Adequate power **Limitations:** No cost calculation Nursing time spent with patients was not measured **Critical Appraisal Rating:** IB
Huang et al., 2018	None	RCT	*n* = 1,455	Tel-Ed: web-based OSA education Tel-TM: CPAP tele-monitoring w/automated patient feedback UC: usual care Tel-Ed + Tel-TM: Tel-Both	90-day CPAP usage. Attendance to OSA evaluation. Change in sleep score (Epworth Sleepiness scale).	Power analysis *F*-test one-way analysis of variance Mixed-effect general linear models Mixed-effect logical regression *T*-tests adjusted with Bonferroni correction	Tel-TM improved 90-day adherence in patients with OSA.	**Strengths:** Number of participants Adequate power **Limitations:** Study was at one site High number of drop outs Adherence not measured after 90 days **Critical Appraisal Rating:** IB
Lugo et al., 2019	None	RCT	*n* = 186	HR: hospital routine	Changes in Quebec Sleep Questionnaire.	*T*-test	CPAP compliance was similar in both groups. There was	**Strengths:** Adequate power

				VSU: virtual sleep unit	Changes in Epworth Sleepiness Scale. Changes in EuroQol Scale.	Two-sample *T*-test Non-paramentric Mann-Whitney Chi-square Fisher's exact test PP sample	no statistically significant difference.	Large sample size Comparable baseline statistics in both groups **Limitations:** Conflicting results in quality of life surveys One diagnosis physician for both groups leads to possible bias **Critical Appraisal Rating:** IC
Pépin et al., 2018	None	RCT	*n* = 306	ITT: intent to treat TM: tele-monitoring BP: blood pressure SBP: systolic blood pressure	Reduction in BP. Pichot Fatigue Scale. CPAP compliance.	Logistic and linear regression model Linear mixed effects model Nonparametric Mann-Whitney test	TM improves CPAP adherence and patient-centered outcomes as reported as improved quality of life and decrease in daytime sleepiness.	**Strengths:** Multi-site study (32) Patients had well-defined homogeneous phenotype of moderate to severe OSA **Limitations:** Sample size not reached **Critical Appraisal Rating:** IC