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Sleep-Disordered Breathing in Geriatric Populations

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Abstract

Purpose of Review The prevalence of sleep-disordered breathing has greatly increased in the geriatric population.

Recent Findings The pathophysiology of sleep-disordered breathing for this population varies from younger populations due to consequences of aging such as loss of neuromuscular tone, soft tissue hypertrophy, and tissue laxity. The importance of treating obstructive sleep apnea is obvious as it is linked to detrimental cardiovascular and cerebrovascular risks with additional effects on quality of life.

Summary Treatment of older patients is best met by evaluating their goals of treatment and meeting it with options that are minimally invasive, cost-effective, and with low pain and morbidity. Non-surgical options such as continuous positive airway pressure and oral appliances are beneficial to those who can tolerate them, but for those that cannot, various surgical options including nasal surgery, palatal stiffening procedures, hyoid suspension, radiofrequency ablation, and upper airway stimulation can provide improvement in their disease and meet their expectations for treatment.

Keywords Sleep-disordered breathing geriatric population

Introduction

Obstructive sleep apnea (OSA) is the intermittent cessation of airflow during sleep which is associated with daytime sleepiness and various comorbidities. This disorder is observed to have a bimodal age distribution with peaks among geriatric populations (age > 60) and those in their 30s and 40s. Although geriatric OSA is less severe comparatively, it is more prevalent. Using an apnea-hypopnea index (AHI) cutoff > 5, some older groups have an OSA prevalence rate as high as 90% in men and 78% in women. Furthermore, an AHI > 15 has been noted to have a prevalence of nearly 50% in some older cohorts [1]. When combining prevalence with an obesity epidemic and aging population, it is anticipated that there will be an increased demand for therapy for sleep-disordered breathing in the future.

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Epidemiology of Sleep-Disordered Breathing in Older Populations

The prevalence of sleep-disordered breathing (SDB) has greatly increased with as many as 44% of individuals greater than the age of 65 demonstrating an apnea/hypopnea index greater than 20 events per hour [2, 3]. Around half of older patients experience moderate obstructive sleep apnea symptoms. Older patients have an associated loss of muscle tone that comes with physiologic aging, and age is an independent factor in both upper airway collapsibility and the increase in pharyngeal resistance during sleep (Table 1) [3, 4]. This loss of neuromuscular tone causes increased tissue collapsibility which leads to sleep-disordered breathing symptoms that in some cases do not manifest until patients are older. Factors such as neuromuscular loss or increased airway collapsibility are less obvious on physical examination and often occur in people of normal weight without other signs of OSA such as large tonsils, large neck circumference, or jaw abnormalities. Therefore, older populations may be underdiagnosed due to

Table 1 Changes in OSA pathophysiology over age spectrum

Factors	< 50 year cohort	> 50 year cohort
OSA prevalence	Less	More
OSA severity	More	Less
Gender	Male	Equal
BMI	Larger	Smaller
Neck circumference	Larger	Smaller
OSA effects	CV morbidity; QOL	QOL
Pathophysiology	Tissue; craniofacial	Neuromuscular

atypical symptoms and differences in phenotype compared with younger populations.

Physiology of Sleep-Disordered Breathing in Older Populations

OSA occurs due to physical obstruction of the pharyngeal airway while asleep. The source of obstruction varies by patient, which frequently involves soft tissue hypertrophy, craniofacial structure, obesity, and decreased neuromuscular tone. The individualized combination of factors then results in the inability of the pharyngeal muscle dilators to overcome upper airway negative pressure, thereby creating a state of collapsibility. Although all can be contributing factors, decreasing neuromuscular tone with age is thought to be a driving factor in geriatric OSA. More specifically, the genioglossus muscle is considered the most important muscle in maintaining pharyngeal airway patency during sleep. Klawe et al. showed decreased genioglossus muscle response to hypoxia in older cohorts [4]. Additionally, Sabooisky et al. demonstrated a slower reaction time of genioglossus dilation in awake patients over 55 years old [5]. This occurs due to remodeling of motor units in this critical upper airway dilator.

OSA evaluation and treatment is further complicated in this patient population as sleep patterns naturally change as part of the aging process. Aging is associated with decreased duration and need for sleep. The average 70-year-old sleeps 6 h per night but will take daytime naps of 1 to 2 h [6]. Furthermore, sleep pattern disruption due to age is mainly due to desynchronization of circadian rhythms [7]. Therefore, geriatric patients are prone to increased sleep latency, decreased sleep efficiency, decreased deep (N3) sleep, and decreased rapid eye movement (REM) sleep. More specifically, a large meta-analysis revealed that with age, the percentage of REM sleep decreases and the percentage of light sleep (stage 1 and stage 2 sleep) increases, thereby demonstrating more disruptions in their sleep patterns as they spend more time in stages of light sleep [8]. In addition, the prevalence of medical conditions and medications known to impact sleep increases with age, such as arthritis, prostate hypertrophy, diuretic use causing nocturia, and pulmonary and renal disorders [9]. These factors require physicians to obtain a thorough history to appropriately evaluate the possibility of normal age-related changes in sleep versus a medical or sleep disorder.

When evaluating for OSA, the most common presenting symptoms are bed partner complaints, daytime somnolence, and snoring, the latter often being the first sign of significant OSA. Complaints of poor sleep quality and insomnia are common in older adults. Other notable symptoms include witnessed apnea, nighttime arousal, daytime sleepiness or fatigue, motor vehicle accidents, poor sleep quality, morning headaches, and mood disorders or memory concerns. Sleep-associated symptoms tend to worsen during the physiologic muscle paralysis of REM sleep. This worsening is caused by decreased muscle tone leading to worsening of upper airway collapse. However, REM sleep decreases, and light sleep, N1 and N2, increases with age until age 50. At this point, there is an increase in nocturnal awakenings, thus further reducing time in both REM and non-REM sleep [6]. This suggests a possible explanation for the lack of progression of OSA in this population as there is decreasing time spent in the physiologic muscle paralysis of REM sleep. Another possible explanation for decreased severity in this population is reduced loop gain. Older patients are less responsive to changes in arterial carbon dioxide levels and subsequently have a less vigorous respiratory response to apnea. This results in less vigorous intrathoracic pressure changes that affect the coronary arteries and cardiac muscle [10, 11]. Therefore, the combination of reduced loop gain, decreased REM sleep, the increased predominance of airway collapsibility, and neuromuscular decline suggests a possible explanation for the increase in prevalence without an increase in severity as demonstrated by Bixler et al. [12].

With regard to physical examination, awareness of tissue laxity of the face and nose in older individuals is required. Sometimes this laxity and its contribution to pharyngeal collapse are not manifested until the individual is asleep. Drug-induced sleep endoscopy (DISE) is a valuable tool for evaluating geriatric patients with overt symptoms of sleep-disordered breathing but an inconspicuous physical exam. In a study of 200 patients undergoing DISE, the most common collapse pattern was found at the level of the velum followed by collapse at the tongue base and epiglottis [13]. An increase in age had a significant association with observed collapse in multiple sites indicating that older patients can have multiple sites of obstruction which may be missed on initial physical exam [14]. DISE allows for a more comprehensive assessment of the anatomical site, degree of severity, and pattern of collapse of the older patient's upper airway during sleep, which may influence decisions for a given patient.

Clinical Consequences of Sleep-Disordered Breathing in Older Populations

Untreated OSA is linked to poor clinical outcomes. Severe OSA has been shown to increase all-cause mortality rate by 2.13-fold [15]. More specifically, OSA is associated with increased cardiovascular and cerebrovascular risk, hypertension, and insulin resistance. Regarding vascular risk, Beaudin et al. demonstrated in a literature review that OSA is linked to detrimental cardio- and cerebrovascular disease risk, specifically in patients with severe OSA [16]. Sudden cardiac death was predicted by an AHI > 20, nocturnal hypoxemia, and an age > 60 therefore suggesting OSA as a risk factor for sudden cardiac death especially in the older population [17]. The correlation between hypertension and OSA has been well documented with hypertension among OSA patients ranging between 35 and 80% [18]. Furthermore, patients with hypertension have an OSA incidence of 40%, and there is an 80% incidence of OSA in patients with resistant hypertension [19]. Lastly, insulin resistance is prominent among OSA patients. Although the increased prevalence of obesity in both the OSA and insulin resistant patient populations clouds the correlation, multiple studies suggest that OSA is likely an independent risk factor for development of insulin resistance [20]. Therefore, OSA may contribute to the development of diabetes and metabolic syndrome.

Although these are important risks to mitigate, possibly the most significant concern for older individuals with OSA is the effects on quality of life. OSA is known to result in reduced energy, decreased concentration, poor job performance, and reduced social interaction. Furthermore, snoring not only disrupts the patient's sleep but also affects the sleep of their bed partner. Improvement of quality of life and depressive symptoms with treatment has been demonstrated [21]. Examples of quality of life change with continuous positive airway pressure (CPAP) include improved executive function, attention, and working memory [22]. Also of note, motor vehicle accidents increased 2.5-fold in OSA patients with a risk reduction of 65 to 78% with the use of CPAP in severe OSA patients [23]. Therefore, the unique phenotype and various poor clinical sequelae of geriatric OSA require different goals and expectations in the management of OSA in this population.

Special Concerns of Older Patients with SDB

Patients presenting to a clinician's office for complaints of SDB will have general concerns including improving their sleepiness, snoring, and overall health concerns such as avoiding stroke or other cardiovascular diseases. However, the geriatric population additionally places significant emphasis on other outcomes that are equally important if not more so in some instances as the previous ones listed. Some of their concerns could include effects of SDB on concentration, memory, real-life tasks, driving, sexual activity, and participation in social events such as card games or sports. It is important to recognize that in many cases, older adults have varying goals regarding treatment of their sleep-disordered breathing and specifically on how it affects their quality of life.

Another important consideration includes the observation that moderate-to-severe obstructive sleep apnea is an independent risk factor in white matter changes, specifically within the frontal lobe [24]. Executive functioning, processing speed domain, and declarative memory all showed small but statistically significant decreases in patients with moderate-to-severe OSA older than 50 years of age without a previous neurological diagnosis [25]. Patients with sleep-disordered breathing were 26% more likely to develop cognitive impairment and have reduced executive function [26]. Not all patients may present with these concerns, but the changes to white matter and possibility of cognitive impairment are another tool in the clinician's toolbox to use to explain to patients the necessity of treatment and the need to adhere to therapy in older patients.

Furthermore, patients with sleep-disordered breathing may notice a decline in their abilities to perform sports or other social activities. A group of patients with a mean age of 55 were treated with positive airway pressure therapy and were found to have a lower handicap while playing golf after 3–6 months of CPAP compared with the untreated controls [27]. The data sounds intuitive as decreased daytime sleepiness allows for better performance at these activities, but this provides further evidence of how sleep-disordered breathing can impact a patient's quality of life. Performance enhancement in geriatric patients' hobbies and skills may be another tool to use when encouraging adherence to various treatment options.

Treatment of SDB in Older Populations

CPAP is the primary treatment for moderate-to-severe OSA and has historically shown benefit in improving daytime sleepiness [28]. Additionally, treatment of severe OSA in patients with CPAP allows for a decrease in primary and secondary cardiovascular outcomes [28]. The data in geriatric populations has been controversial. The PREDICT trial showed that CPAP reduced the Epworth Sleepiness Scale (ESS) for patients with a starting score of > 9 and kept this reduction at a 12 month follow up [29]. The data for the cardiovascular benefit in the geriatric population is not as clear as it has been for the middle-aged population although there is evidence that patients > 65 with untreated severe OSA have an increase in cardiovascular events and all-cause mortality [30]. Furthermore, CPAP may provide some elderly patients with improvement in quality of life. For example, one study found that CPAP-adherent patients showed significant improvement in tests of mental agility and memory [31]. It is important to remember for this population group that their goals regarding sleep may be different from the middle-aged population which may affect treatment choice.

Oral appliances have appeared as an alternative to continuous positive airway pressure and exist in different forms as the one-piece (Monobloc) and two-piece (upper and lower plate). Many randomized controlled trials have established the efficacy of oral appliances when compared with placebo or inactive devices that do not provide mandibular advancement in reducing snoring, daytime sleepiness, and the AHI scores. When compared with CPAP, CPAP reduces AHI to a greater degree than the oral appliances but has lower rates of adherence to therapy [32]. Patients have reported jaw discomfort, dry mouth, and temporomandibular joint pain with these devices which are generally mild and can be managed with appropriate supportive care and may have less overall morbidity and mortality than various surgical options. One challenge in older populations is the need for dentition of adequate quality and strength to maintain use of the device over time.

A variety of surgical options exist for treatment of sleep-disordered breathing, some of which have become newly available in the past decade. Selection of the proper surgical techniques requires a personalized approach and shared decision making between the surgeon and the patient in order to address the patient's differences in physiology as well as individual expectations. Particularly, in geriatric populations, surgical treatment focused on addressing the increased collapsibility of the tissue is a rational approach since SDB in this population is largely associated with loss of neuromuscular tone with increasing age [41–44]. The guiding themes for procedure selection in this population should include selecting treatments that are cost-effective, minimally invasive, and with low pain and morbidity. A key point for treatment is to match the severity (morbidity) of the intervention to the patient's outcomes of interest.

Nasal surgery can be an appropriate option for older adults as it can generally be performed as an outpatient procedure or in some cases in the office and has a low morbidity. Various nasal procedures include septoplasty, inferior turbinate reduction, and interventions to address collapse of the internal nasal valve. A meta-analysis revealed that nasal surgery for older adults showed a significant reduction in their ESS (mean reduction of 3.5) and respiratory disturbance index (RHI) (mean reduction of 11). Of note, there was no improvement of the apnea-hypopnea index indicating that although nasal surgery improves quality of sleep and reduces sleepiness, it may be inadequate as a stand-alone therapy for OSA [42]. A more recent meta-analysis compared the results of nasal surgery in patients with and without OSA that had nasal obstruction. The ESS scores improved in patients with OSA that had nasal surgery indicating that nasal surgery decreases daytime sleepiness [33]. Neither groups had improvement in their AHI, but their significant subjective improvement allows for nasal surgery to be a good option for patients with concerns about how sleep-disordered breathing affects their daily activities.

Options for affordable, low-morbidity, office-based therapy include various techniques of soft tissue remodeling and/or stiffening. These may include radiofrequency ablation of the base of the tongue, a procedure which has been shown to reduce the Epworth Sleepiness Score by 31% and respiratory distress index additionally by 31% at short term follow-up (< 12 months) with infrequent complications [34]. However, a limitation providing caution is the majority of studies examining this therapy alone excluding patients over the age of 65. More recent data has shown that when radiofrequency ablations is combined with pillar implants, the patient's ESS and witnessed visual analogue scale (VAS) completed by their bed partner decreased post-operatively at 3 month follow-up [35]. This study also measured quality of life changes using a Short Form-36 questionnaire that showed statistically significant improvements in the areas of bodily pain, emotional roles, and general health. A single-center, randomized controlled trial of pillar implants revealed that they act singularly to reduce the HI and AHI by almost half and show modest improvements regarding the ESS and witnessed VAS for patients with mild to moderate sleep apnea [36]. A meta-analysis of pillar implants confirmed these results and revealed improvements in snoring for patients with mild to moderate sleep apnea [43]. It is important to reinforce that these options do not necessitate general anesthesia which makes them particularly viable options for geriatric patients because of the lower morbidity and mortality.

Intraoperative surgical procedures in older patients frequently focus on advancing or stretching the collapsible segment of the airway as opposed to removing tissue at that level. Suspension of the hyoid bone has been investigated as a potential treatment to collapse of the hypopharyngeal (supraglottis; epiglottis) airway in patients with OSA. The data historically has been unfavorable for hyoid myotomy and suspension as a stand-alone compared with its use with other techniques such as genioglossus advancement or radiofrequency ablation. The procedure has shown some success when used with other concurrent therapies such as nasal surgery or palatal surgery [37]. However, in a recent smaller study performed on an older subset of patients (average age of 55), hyoid myotomy and suspension alone revealed an improvement in AHI and the lowest oxygen saturation (LSAT) but not the ESS [38]. The improvement seen in this subset of patients could be related to the reduced neuromuscular tone seen in older patients resulting in pronounced hypopharyngeal obstruction.

Upper airway stimulation (UAS) therapy has emerged as an alternative therapy for patients who require CPAP but struggle with adherence for a variety of reasons. UAS principally targets OSA caused by loss of upper airway neuromuscular tone and dilator function and therefore may be a particularly effective therapy in older individuals. Current UAS devices work by stimulation of the hypoglossal nerve to cause tongue protrusion therefore reducing upper airway soft tissue collapse. At 12 months following surgical implantation, the STAR trial of the Inspire UAS device revealed the median AHI score decreased 68% in implanted subjects from an average baseline of 29.3 events per hour to 9.0 events per hour [37]. A decrease in the AHI by greater than 50% and a lowered AHI score to less than 20 was achieved in 75% of patients enrolled in the trial [39••]. Additionally, scores on the ESS and FOSQ (Functional Outcomes of Sleep Questionnaire) demonstrated statistically significant improvement indicating better subjective outcomes for these patients, and the percentage of patients reporting a normal FOSQ and ESS score were maintained at 67% and 78% respectively at 5 years of follow-up [39••]. Eight participants of the 126 original participants (6.3%) had a total of 9 serious device-related adverse events after 5 years which included surgical repositioning or replacement of the neurostimulator or implanted leads. Of note, many of the adverse effects associated with the Inspire device such as sore throat, pain at the incision site, temporary tongue weakness, or tongue soreness resolved after patients adjusted to the device, and the overall rate of serious adverse events was less than 2% [37, 39••]. Interestingly, the largest assembled cohort to date of patients undergoing upper airway stimulation therapy revealed a positive association for age for use of the device. At each year increase, there was 9% increased odds ratio of UAS usage [40•]. This data gives increasing evidence that this device is beneficial for an older population, and that they are more likely to adhere to the device.

Conclusion

Sleep-disordered breathing is becoming a common problem among elderly individuals and increasing in prevalence over time while the “cure” for OSA continues to remain elusive. It is important to note the difference in phenotype for SDB for older patients and younger cohorts. Many older patients emphasize concentration, memory, and their performance in real-life tasks in addition to the physical risks such as atrial fibrillation, stroke, and other cardiovascular diseases. Older patients have increased collapsibility due to loss of neuromuscular tone which may not be immediately evident on routine physical exams. Assessing the patient’s goals when determining treatment options is a critical part of determining which treatment options will be more successful for the individual patient. The use of drug-induced endoscopy on these patients can provide valuable insight about the degree and type of collapsibility present. CPAP has continued to be the first line of treatment for patients with obstructive sleep apnea as it shows better reduction of AHI than other non-surgical devices such as oral appliances. However, no matter the age, adherence to CPAP can be a determining factor when seeking the best treatment option for patients. If the non-surgical options are intolerable, surgical options should be considered. Particularly for this population, the focus should be on surgical options that are minimally invasive, cost-effective, and low association of pain and morbidity with rapid recovery. The severity of intervention should match the severity of the disease while improving the outcomes of interest for the patient.

Compliance with Ethical Standards

Conflict of Interest A. Kate Ramsey and Leighton Reed declare that they have no conflict of interest.

M. B. Gillespie is actively involved in the development and investigation of new devices for the treatment of obstructive sleep apnea (OSA). Dr. Gillespie reports personal fees from Cook Medical, Medtronic, and Invicta. He also is on the Scientific Advisory Boards (stock options) for Zelegent and CryOSA. He is also a Clinical Trial Investigator for Olympus, Inspire, and LivaNova.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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