Medical Education Systems Inc.

Anesthesia and Sleep Apnea

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TOLL FREE 1-877-295-4719
FAX (619) 295-0252
EMAIL: Info@mededsys.com
www.mededsys.com
P.O Box 81831 San Diego, CA 92138-3939

Anesthesia and Sleep Apnea

Learning Objectives

Upon successful completion of this continuing education course, you should be able to:

- Identify why sleep apnea is of concern to anesthetists, explaining the various risks
- Describe the nature and effects of sleep and anesthesia on ventilation
- Identify and discuss the effect of age and other physiological variables in sleep
- Explain the various potential dangers of anesthesia and sleep disordered breathing

Joseph Kinny Meadows. Falstaff and Mistress Quickly, 1869.

Wednesbury Art Gallery, England.

J. A. Loadsman
Department of Anesthetics, Royal Prince Alfred Hospital, Missenden Road, Camperdown NSW 2050, Australia. **And D. R. Hillman**
Departments of Pulmonary Physiology and Anesthesia, Sir Charles Gairdner Hospital, Nedlands WA 6009, Australia

Falstaff: Now, Hal, what time of day is it, lad?
Prince Henry: Thou art so fat-witted, with drinking of old sack, and unbuttoning thee after supper, and sleeping upon benches after noon . . .
(Act I, Scene II)

Poins: Falstaff! - fast asleep behind the arras, and snorting like a horse.
Prince Henry: Hark, how hard he fetches breath . . .
(Act II, Scene IV)

King Henry IV Part I
William Shakespeare

While the first detailed description of *obstructive sleep apnea* (OSA) only appeared in 1966,[31] many had noted its characteristics prior to this. The best known of these descriptions is Dickens' portrayal of Joe the Fat Boy in *The Posthumous Papers of the Pickwick Club*, although it would seem that Shakespeare had observed the symptoms at least three centuries earlier. Considering Shakespeare's comic intent, it is clear that the audience would have been aware of them also. This suggests the problem to be a common one as several large studies now confirm.[11] [120] [139] These studies demonstrate that between 2 and 4% of middle aged adults have clinically significant sleep apnea with a male:female ratio of 2:1.

Sleep apnea is of particular concern to anesthetists. The patient with disordered breathing during sleep is likely to also have disturbed breathing when sedated. This effect is compounded by sedation-related compromise of arousal, the mechanism that protects the sleeping patient from life threatening consequences of a breathing disturbance. Furthermore, the upper airway abnormalities that predispose to breathing obstruction during sleep may also make tracheal intubation difficult.

This review is presented in three sections. In the first, sleep-related breathing disorders are defined and the pathophysiology, clinical features, and management discussed. In the second, the nature of sleep and anesthesia and their effects on ventilation are considered and in the third, the anesthetic management of patients with sleep apnea examined.

Sleep-related breathing disorders

Definitions

Disappointingly, there is as yet no broad consensus regarding standard definitions, including thresholds of significance, for many of the terms used to describe sleep-related breathing disturbances, although a recent report has addressed these issues.[4] It is generally agreed that an *apnea,* defined as a cessation of airflow, has to exceed 10 s duration to be considered significant. No standard definition of an *hypopnea* exists. It is usually defined as a reduction in airflow or respiratory effort for more than 10 s accompanied by a desaturation of 3% or more and/or electroencephalographic evidence of arousal.[4 126] The *apnea hypopnea index* (AHI) is the number of apnoeas and hypopneas per hour of sleep and is used more or less interchangeably with the term *respiratory disturbance index*.

The apnoeas may be obstructive, central or mixed. Obstructive apnoeas are characterized by persistent effort without airflow, while with central apnea, effort is absent. OSA, where the apnoeas are predominantly obstructive or mixed, is much more common than *central sleep apnea*. *Sleep disordered breathing* is a term commonly used to encompass both these and other related conditions, some of which are mentioned below. The term *obstructive sleep apnea syndrome* is applied when OSA is accompanied by daytime sequelae such as excessive daytime sleepiness.

As there is a continuum of possible AHIs from trivial to severe, defining the presence of clinically significant sleep apnea is somewhat arbitrary. It is generally agreed that the AHI should exceed five to be considered significant, with some advocating an AHI of 10 or more. It has been suggested that an AHI of five to 15 represents mild sleep apnea, 15-30 moderate and greater than 30, severe.[4] However, the magnitude of associated symptoms and hypoxemia also need to be considered when severity is determined.[77]

Hoffstein and Szalai[51] found that even with the inclusion of a ‘clinical impression’ by the examining sleep physician, clinical features could not reliably predict the presence or otherwise of OSA. Many patients, brought along to clinics by concerned bed partners who have witnessed apnoeas, deny symptoms. Conversely, some patients exhibiting all the daytime features of OSA have few apnoeas or hypopneas. Some of these habitual snorers have been found to have recurrent arousals from sleep resulting from increases in upper airway resistance not sufficient to cause apnoeas or hypopneas as usually defined, a condition now known as *upper airway resistance syndrome*.[45]

Complicating matters still further is the variation in daytime sequelae, a few patients, and women in particular, presenting not with excessive daytime sleepiness but with other symptoms such as anxiety.[5] Nor do the above criteria always apply satisfactorily to children.[97]

Pathophysiology

OSA

A narrow, floppy upper airway provides the pathophysiological basis for OSA. This may have a congenital or acquired origin (Table 1). Usually such an airway does not cause problems during wakefulness. However, with sleep the associated loss of skeletal muscle tone makes the upper airway still narrower and floppier, particularly during rapid eye movement (REM) sleep when muscle relaxation is profound. This has two important consequences as gas is accelerated through it. First, the structures will tend to vibrate as turbulent flow patterns are produced, with snoring the result. Second, the pharynx will tend to collapse due to the Bernoulli effect, with resultant partial or complete obstruction. Obstruction will persist until sleep is interrupted and muscle tone is restored. Usually these interruptions are momentary arousals lasting less than 15 s and the sufferer is unaware of them. Occasionally, the obstructive event will result in an awakening, and the sufferer may complain of waking suddenly or with a snort or a snore. With arousal, breathing is restored and after a few breaths deeper sleep will resume with recurrence of the problem as the muscles again relax. In the more severe cases of OSA, this cycle of apnoeas and arousals may occur hundreds of times a night. In the more subtle cases, it may only occur in certain sleep stages (particularly REM sleep) and postures (particularly supine) or after alcohol consumption. The result of this constant sleep disruption is lethargy and somnolence during wakefulness.

Table 1 Known and suspected predisposing conditions for obstructive sleep apnea

Condition	Examples	Contribution
Obesity, body fat distribution[41 46]	Adult obesity, Prader-Willi syndrome	Complex and ill-defined
Race/genetics[6 92]		?Anatomical similarity
Age[13]		?Tissue laxity
Male gender[139]		Unclear
Alcohol,[123] sedatives, analgesics, anesthetics		Muscle relaxation, depressed arousal
Smoking		?Chronic nasal congestion, pharyngeal edema

Nasal obstruction[82]	Septal deviation, chronic nasal congestion	Increased pharyngeal negative pressure
Pharyngeal obstruction[47]	Tonsillar and adenoidal hypertrophy	Increased pharyngeal negative pressure
Cranio-facial abnormality[20 39 78 95 **118** 125]	Down's, Pierre-Robin, Treacher-Collins, Apert's, Crouzon's, Beckwith-Wiedemann, achondroplasia, acromegaly, fragile-X	Mid-face hypoplasia, macroglossia or micrognathia
Laryngeal obstruction	Laryngomalacia, tracheomalacia	Laryngeal collapse
Endocrine/Metabolic[40]	Hypothyroidism, androgen therapy, Cushing's	Upper airway infiltration or myopathy, obesity
Neuromuscular disorders[29 42 44 52 83]	Stroke, cerebral palsy, head injury, Shy-Drager, poliomyelitis, myotonic dystrophy, dysautonomia, tetraplegia	Disordered pharyngeal neuromuscular function
Connective tissue disorders[19]	Marfan's	Abnormal upper airway connective tissue
Storage diseases[109]	Mucopolysaccharidoses	Macroglossia
Chronic renal failure[63 73]		Unclear

Central sleep apnea

Inadequate breathing during sleep due to diminished or absent respiratory effort (central sleep apnea) may occur in association with disorders of ventilatory control or neuromuscular function or where the respiratory musculature is excessively loaded (Table 2). Patients with such conditions have diminished ventilatory capacity that may be sufficient for their needs during wakefulness but results in hypoventilation during sleep when the drive to ventilation is reduced and the compensatory mechanisms fail. Consequences include hypoxaemia, hypercarbia, sleep disruption and daytime somnolence. Unrecognized and untreated, polycythemia and/or respiratory and right heart failure may supervene if sleep related hypoventilation is sufficiently severe. Similar consequences can accompany hypoventilation due to severe OSA.

Table 2 Known and suspected predisposing conditions for central sleep apnea

Condition	Examples	Contribution
Neuromuscular disorders[32 52]	Poliomyelitis, amyotrophic lateral sclerosis, muscular dystrophy	Respiratory muscle weakness
Excessive respiratory load[41]	Obesity, airways disease, kyphoscoliosis	Excessive elastic, resistive or threshold loading of muscles
Disordered peripheral chemosensitivity[22 115]	Cardiac failure, bilateral carotid body excision	Delay or failure of ventilatory feedback from peripheral chemoreceptors
Disordered central ventilatory control	Stroke, head injury	Impaired ventilatory drive
Endocrine/metabolic[39]	Acromegaly	?Increased growth hormone and insulin like growth factor 1

Symptoms and signs

The key symptoms present in most cases of sleep apnea are heavy snoring, occasional sudden awakenings that may be associated with momentary choking, apnoeas witnessed by a bed partner and excessive daytime sleepiness. Obtaining a history from the bed partner can be vital in eliciting several of these symptoms. Apart from these cardinal features, other recognized symptoms are listed in Table 3 and the signs in Table 4. While the symptoms lack specificity, in many cases a reasonably confident diagnosis may be made on history alone.

Table 3 Symptoms associated with sleep apnea

Adults	Children[47]
Heavy snoring	Snoring
Excessive daytime sleepiness	Restless sleeping
Witnessed apnoeas	Somnolence
Sudden awakenings with ‘choking’	Aggression/behavioral problems

Accidents related to sleepiness	Hyperactivity
Poor memory/concentration	Odd sleeping postures
Delirium	Frequent coughs/colds
Gastro-oesophageal reflux	
Mood/personality changes	
Nocturnal sweating	
Restlessness during sleep	
Nocturia	
Enuresis (uncommon)	
Dry mouth on awakening	
Nocturnal or morning headache	
Impotence	
Nocturnal epilepsy	

Table 4 Signs associated with sleep apnea

Oedematous soft palate or uvula
Long soft palate and uvula
Decreased oropharyngeal dimensions
Nasal obstruction
Maxillary hypoplasia
Retrognathia
Central adiposity/increased neck circumference
Hypertension and other cardiovascular consequences
Conditions/syndromes (listed in Tables 1 and 2) associated with sleep apnea

Investigation

The gold standard investigation for sleep apnea is full overnight *polysomnography* (PSG) from which the type and severity of any apnea may be determined. Electroencephalogram (EEG), electro-oculogram and submental electromyogram (EMG) are recorded for the purpose of staging sleep. Respiration is assessed by monitoring oronasal airflow (pressure transducer or thermistor), respiratory effort (inductance or impedance pneumography to monitor thoracoabdominal motion and/or diaphragmatic EMG) and pulse oximetry. Additionally, it is usual to monitor body position, sound and electrocardiogram. Videotape to record body movements and transcutaneous carbon dioxide are also used in selected cases. Subsets of these may be used for screening purposes, an example being the MESAM 4 system using oximetry, heart rate, snoring and position.[119]

Originally, the PSG data were printed out in real time using a polygraph. This method has now largely been replaced by digital storage techniques using a variety of commercially available software packages. Either way, the records are examined in 30 s 'epochs' and the sleep stage for each epoch is determined using the criteria of Rechtschaffen and Kales.[91] Respiratory events are scored using the definitions listed above and the total number of events, their duration and the degree of desaturation summarized for the whole night and for specific sleep stages.

Nasopharyngoscopy or upper airway imaging (lateral cephalometry or computed tomography) may be performed to guide treatment; for example, whether or not surgery will be of any benefit.

The results of these investigations are relevant for anaesthetists as they give some indication of the likelihood of difficulty with intubation or airway maintenance.

Sequelae

There are many sequelae of sleep apnea which have limited relevance to anesthesia. A variety of confounding factors exists which make this issue a complex one.[69] The symptomatic accompaniments have already been listed (Table 3) and other sequelae are summarized in Table 5.

Table 5 Potential sequelae of sleep apnea

Neuropsychological[58 59 71]	Sleepiness, impaired memory and cognition, decreased vigilance, increased accident risk, anxiety and depression, chronic headache, intracranial hypertension
Cardiovascular[17 53 56 68 74 135]	Hypertension, ischaemic heart disease, cerebrovascular disease, right heart failure
Pulmonary[72 106]	Hypoxaemia, hypercapnia, pulmonary hypertension

Endocrine[15 38]	Decreased growth hormone and testosterone levels, diabetic instability
GIT[62]	Gastro-oesophageal reflux

While yet unproven, several of the acute changes associated with apnoeic episodes have the potential to influence perioperative progress. Possible complications include arythmias, myocardial ischemia, cerebrovascular insufficiency, intracranial hypertension, mental dysfunction and poor wound healing.[30 34 35 58 93 98 99 101]

Chronically, if the sleep apnea is severe enough, respiratory and right heart failure may develop as the result of persistent, severe nocturnal hypoxaemia and hypercapnia, further increasing the risk of anesthesia and surgery.

Treatment

OSA

In mild cases, conservative measures alone may lead to a satisfactory improvement. These measures include weight loss, reduction of alcohol or sedative consumption, sleeping laterally, and cessation of smoking. In most cases, however, these form an adjunct to more aggressive therapy, either because they are insufficient by themselves or because they prove difficult to achieve.[37] Trials of drugs that alter sleep architecture or upper airway muscle tone and electrical stimulation of the upper airway muscles during sleep have so far proved disappointing.

Introduced by Sullivan in 1981,[121] nasal continuous positive airway pressure (nCPAP) remains the treatment of choice for OSA of at least moderate severity.[36] This treatment is highly effective and prevents obstructive events by pneumatically splinting the upper airway.[90] Compliance, however, is variable and in milder forms of sleep apnea, where daytime symptoms are mild, it is often not well accepted by patients, being moderately intrusive.[36]

In severe OSA, particularly when associated with morbid obesity or other coexisting disease such as chronic airflow limitation, the patient may present in respiratory and right heart failure. In addition to the obstructive apnoeas, central sleep hypoventilation can be present in such cases, particularly during REM sleep. If so, initial control is often best achieved with non-invasive bi-level ventilatory assistance. This involves the delivery of intermittent positive pressure ventilation (IPPV) with positive end-expiratory pressure via a nasal or face mask using BiPAP (*Bilevel positive airway pressure*) or similar device. Once control of sleep hypoventilation and respiratory failure have been achieved it is often possible to convert to CPAP, a cheaper therapy, if the predominant problem has been OSA.[89]

The use of oral appliances that reposition the mandible (forwards), increasing the pharyngeal dimensions, is becoming more common for the treatment of snoring and milder forms of OSA.[2 86] Potential complications of these devices such as temporomandibular joint dysfunction have not yet been widely investigated,[36] but there is now evidence that they are associated with dental side-effects which, while generally mild and temporary in nature, may necessitate treatment cessation in some individuals.[88]

Palatal surgery is a reasonable treatment alternative for habitual snoring but a less certain treatment for OSA.[1 3 37 110] Surgical correction of nasal obstruction is important but, of itself, does not usually result in resolution of sleep apnea. Surgical removal of obstructing lesions in the pharynx can be definitive and tonsillectomy/adenoidectomy is a front-line treatment of obstructive sleep apnea in childhood.[47] Maxillofacial surgery may be necessary where craniofacial abnormalities exist that are associated with OSA,[23] but its use is limited.[18] Tracheostomy, the main method of treating sleep apnea prior to the development of CPAP, is now only indicated in life-threatening OSA when non-invasive forms of respiratory support are not tolerated.

Central sleep apnea

Patients with sleep-related hypoventilation due to neuromuscular disease or one of the other causes listed in Table 2 may respond to treatment with CPAP or respiratory stimulants. More usually, if sufficiently severe, non-invasive ventilatory assistance is required and IPPV via nasal or face mask is the method of choice.[37] In those patients requiring IPPV for greater than 12 h a day and in patients with inadequate airway patency or protection, a tracheostomy may be necessary. External negative pressure ventilation, such as with a cuirass, may exacerbate or induce upper airway obstruction[49] and the cumbersome nature of this treatment has rendered it largely obsolete.

Sleep and anesthesia - their nature and effects on ventilation

Sleep

Unlike anesthesia, sleep is a state of *rousable* unconsciousness. While much is known about the electrochemical factors influencing sleep onset and the sleep-wakefulness cycle, the exact function of sleep remains unclear, apart from the fact that it is essential for well-being.

Electrophysiology of sleep

The EEG was first used to investigate and characterize sleep by Loomis and colleagues in the 1930s.[76] It was not until 20 yr later that Aserinsky and Kleitman recognized the association between eye movement and the phases of sleep[7] but this soon led to the definition of sleep stages based on EEG, eye movements and muscle tone, more or less as we now know them (non rapid eye movement (NREM) stages 1 through 4 and REM), by Dement and Kleitman in 1957.[24]

Rechtschaffen and Kales subsequently refined these definitions into guidelines that remain the international standard after 30 yr of use.[91]

A single pair of EEG leads may be used to stage sleep. Typically, one electrode is placed adjacent to the vertex (C3 or C4) and another over the contralateral mastoid (A2 or A1). The differential input from these is referred to a third, often the other mastoid. An occipital electrode may also be used. For the eye movements, another pair of electrodes is used, one *above* the outer canthus of one eye, the other *below* the outer canthus of the other eye. Both are referred to one of the mastoids. This results in out-of-phase deflections for both horizontal and vertical eye movements, allowing differentiation from artifacts, which are usually in-phase. A third pair of electrodes is placed under the chin to monitor the EMG.

Relaxed wakefulness is characterized by sinusoidal alpha (8-12 Hz) and low voltage, mixed frequency activity on the EEG, accompanied by eye movements, blinking, and high submental EMG tone. With sleep onset (stage 1) there is muscle relaxation, slow horizontal rolling of the eyes and a marked reduction in the amount of alpha activity, leaving mainly the low voltage, mixed frequency component.

Stage 2 may be associated with a further reduction in the EMG, but it is particularly defined by the appearance, superimposed upon the stage one type EEG background, of sleep spindles (short bursts of 12-14 Hz activity similar to waking alpha) and K-complexes (a sharp negative wave immediately followed by a broader, high voltage positive component). K-complexes may be either spontaneous or a response to an external stimulus, and are frequently closely associated temporally with spindles.

Stages 3 and 4, together referred to as *slow wave sleep* (SWS), are characterized by high voltage delta (1-4 Hz) activity (hence its other less common name, *delta sleep*). If the epoch has between 20 and 50% of its record consisting of slow waves then it is scored as stage 3. Epochs containing more than 50% SWS are classified as stage 4.

Stage REM has an EEG pattern similar to stage 1. It is, however, clearly defined by the presence of episodic rapid eye movements, very low EMG amplitude and a variety of other physiological changes as described below.

The typical sleep pattern

Of the few previous depictions in the anesthetic or surgical literature of the normal human sleep pattern,[61 103 104] at least one is somewhat inaccurate[104] and none mention the changes in this pattern with age. Knowledge of the typical pattern is necessary before assessment of perioperative changes can be made and as a number of assumptions and speculations have been drawn from relatively few observations of perioperative sleep this is all the more important.

In *young adults*[24 60 136] a brief initial period of stage 1 is usually followed by stages 2, 3 and 4 in that order. The SWS component normally predominates this first NREM period and after about 70 min of sleep the first REM stage occurs, preceded by a period of stage 2. This cycle is repeated, depending upon the total sleep time, up to six times but the later cycles usually lack stage 4.

The REM periods tend to lengthen as sleep progresses while the cycle length, averaging 70-90 min, shortens as the NREM component decreases more than the increase in REM. Stage 2 is the predominant stage for the total period of sleep, usually making up about 50%. Stage 1 totals about 5%, SWS about 20% and REM about 25%. The graphical depiction of sleep in stages is known as the hypnogram and an example from a young adult male is shown in Fig. 1.

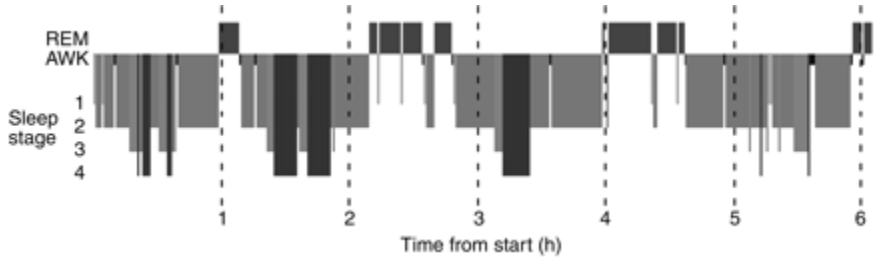

Fig 1 Actual hypnogram of a young adult male medical student - a graphical depiction of the sleep stages during one night's sleep (recorded and manually scored with a commercial sleep monitoring system; Compumedics, Melbourne, Australia). REM=rapid eye movement sleep; AWK=awake or movement time. The final REM period ended prematurely as a consequence of study termination.

Influence of age

The changes in sleep pattern with age are profound[28] and have the potential to heavily influence interpretation of studies into perioperative sleep. Total sleep time shows a precipitous decline during adolescence from an average of 10 h day^{-1} or more at age 6 yr to about 7.5 h in early adulthood. There is then a plateau until old age when a further but less dramatic decline occurs. The proportion of time spent in bed but awake remains at a few per cent until mid-life whereafter it rapidly increases to about 20% or more in old age. The number of arousals per night increases more linearly. As a result of these changes ageing is associated with more frequent and prolonged interruptions to sleep.

REM sleep decreases from more than 50% of total sleep time in neonates[117] to about 30% in later childhood before a plateau of about 25% for most of adulthood and a further decline to about 20% late in life. Stage 4 sleep, on the other hand, displays no plateau, its total amount declining sharply during adolescence, then halving again between the ages of 20 and 60 yr. This decline in stage 4, about half of which normally occurs in the first sleep cycle on any given night, results in a shorter first cycle and hence a reduction in REM latency, the time to first REM onset. This first REM period also becomes longer in old age, leading to a more even distribution of REM throughout the sleep cycles, the number of which is about the only sleep variable to remain constant with age.

Other physiological variables in sleep

A complete account of the gamut of physiological changes during sleep is outside the scope of this work. Each stage of sleep has a fairly distinct pattern of physiological phenomena [26] [43] and the complexity is such that any attempt at classifying sleep stages according to some arbitrary measure of 'depth' amounts to gross oversimplification. Nevertheless, in order to examine the impact of sleep in the perioperative period knowledge of some of these changes is required.

Skeletal muscle function. All skeletal musculature, be it postural, chest or abdominal wall, diaphragm or upper airway, is subject to state-related activity changes. There are, however, marked differences between the groups. The tone of postural muscles, compared with wakefulness, is reduced somewhat in NREM and almost completely abolished in REM. This is a consequence of hyperpolarization of alpha motor neurones[108] which is most marked during the transition from NREM to REM sleep and during bursts of eye movement activity, commonly referred to as *phasic REM sleep*.[81] Despite this, phasic REM is characterized by rapid, random fluctuations in motor neurone membrane potential, hence varying levels of excitation and inhibition resulting in the eye movements and twitches of limbs and facial muscles. This occurs against the background active inhibition of *tonic REM sleep.* In contrast to non-respiratory muscles, the inspiratory activity of the chest wall, accessory and diaphragm muscles is preserved in NREM, as is the expiratory activity of the abdominal wall.[48] [112] [113] [124] During REM, the tonic and phasic activity of all of these muscles except the diaphragm is greatly reduced. The diaphragm's phasic activity is preserved, albeit on a background of reduced tone.[128] This explains the profound hypoventilation seen when patients with diaphragmatic weakness enter REM sleep.[111] The upper airway musculature follows the same pattern as the postural muscles,[107] increasing the tendency to collapse,[55] especially during REM, but as some muscles are constrictors rather than dilators, and as the state-related changes differ from muscle to muscle and from individual to individual, this tendency may not be universal.

Ventilation-perfusion relationship. Functional residual capacity (FRC) is reduced during sleep, presumably as a consequence of sleep related changes in respiratory muscle tone together with gravitational effects of the supine position on the lung and abdominal contents.[54] This results in atelectasis in the dependent regions of the lung with shunt, particularly in the case of patients with obesity and chronic lung disease.[10]

Load compensation. The application of resistive or elastic respiratory loads during wakefulness leads to a rapid increase in the motor output to the respiratory musculature as well as an increase in the duration of inspiration.[57] [134] [137] In addition, increased negative pharyngeal pressure resulting, for example, from increased upper airway resistance leads to an increase in the neural output to upper airway dilator muscles.[79] [132] Sleep not only imposes both resistive and elastic loads on the respiratory muscles, via upper airway narrowing and decreasing FRC, respectively, but it also compromises the compensatory mechanisms that cope with these changes. During NREM sleep, load compensation occurs but is slow and incomplete[7] [134] [137] with increased reliance on chemical drive which itself may be depressed (see below), the end result being a degree of hypoxaemia and carbon dioxide retention. The situation in REM is worse still, with a further increase in loading and a simultaneous failure of intercostal, accessory, upper airway dilator and expiratory muscles to assist in the necessary compensation.

The coexistence of either neurological or mechanical respiratory disease, already challenging the compensatory mechanisms, further increases the tendency to hypoventilation.

Ventilatory control. Wakefulness has an important stimulatory effect on ventilation. While it appears that chemosensitivity is important for maintaining ventilation during sleep, as indicated by the increased sleep-related hypoventilation seen in patients with carotid body denervation,[22] the effects of sleep on chemoreception are far more complex and difficult to define. Standard tests of acute ventilatory responses have demonstrated varying degrees of inhibition, particularly of the response to combined hypoxia and hypercapnia, but these may overestimate the reduction in chemosensitivity as other factors such as increased upper airway resistance, impaired load compensation and changes in cerebral blood flow need to be considered.[26] On the other hand, sleep does unmask the 'apnoeic threshold', not normally seen in wakefulness.[25] Thus, in sleep, apnoeas or hypopneas can be produced by lowering the P_{CO_2}, as may occur during hypoxic hyperventilation.[12] This reduction in ventilation may then result in an overshoot into hypoxic hypercapnia again, leading itself to hyperventilation and consequently a cycle of hypoxia-induced periodic breathing with large swings in oxygen saturation--a variant of *central sleep apnea*. Ironically, sufficiently large increases in upper airway resistance may be one factor preventing periodic breathing in some subjects by limiting the hyperventilation.[26] Despite the lack of clarity with respect to sleep effects on chemosensation, it appears that there is a reduction in output from medullary respiratory neurones, particularly during NREM, whereas in REM the output from these neurones tends to be related to the variability in breathing pattern.[26] REM, however, is associated with a depression of the arousal responses to hypoxia and hypercapnia, leading to a tendency for apnoeas to be longer and desaturations more severe in that sleep stage.

Anesthesia

In contrast to sleep, anesthesia is a state of *unrousable* unconsciousness.

The electrophysiological nature of anesthesia is an area of intense ongoing investigation, particularly now with devices allegedly able to monitor 'depth' of anesthesia becoming available. It is, however, a very complex issue as different anesthetic agents have different effects on the EEG[14] so that no unitary pattern indicating anesthetic 'depth' exists. It is, therefore, very difficult to make any electrophysiologic comparisons between sleep and anesthesia, although attempts are being made,[114] and such comparisons are probably irrelevant in any case, as the two states are quite distinct. With few exceptions, anesthetic and sedative drugs produce a dose dependent depression not only of consciousness, but also of most other vital functions, including all those related to respiration. Apart from abolition of the stimulatory effects of wakefulness these include depression of hypoxic and hypercapnic responses,[116] load compensation reflexes[85] and the arousal responses that normally protect against asphyxia. As with sleep there is depression of skeletal muscle tone with reduction in FRC, predisposing to atelectasis, and upper airway muscle relaxation predisposing to obstruction. These effects are compounded by reduction in the phasic activity of intercostal and accessory respiratory muscles, increasing dependence on the diaphragm, and of the upper airway muscles during inspiration, further predisposing to obstruction as this activity acts to stiffen the airway as intraluminal pressure falls.[127]

The presence of a vigilant anesthetist to monitor and maintain vital functions during anesthesia protects the patient from these effects. However, drug induced sedation and post-anesthesia drowsiness, where the borders between wakefulness, sleep and anesthesia are less distinct and monitoring perhaps less rigorous, present great potential danger to the patient with a sleep-related breathing disorder because of the depression of these responses.

Sleep in the post-operative period

There has only been one study examining the effects of general anesthesia alone (with isoflurane) on subsequent sleep and it would appear that this effect is negligible.[84] Other studies imply that the type of anesthesia is also not important.[61 75] The addition of a surgical insult changes things considerably.[102] Sleep architecture is disrupted to a degree which is generally proportional to the 'magnitude' of the surgery as is the duration of the disruption, but it is important to note that there is considerable inter-individual variation and specific situations where the generalization may not hold. The disturbance takes the form of reduced total sleep time with a disproportionate reduction in REM and SWS.[8 61] At some point during the first postoperative week there is a rebound, firstly of total sleep time with mainly stage 2 usually, then a resurgence of REM ('REM rebound') and to a lesser extent SWS.[65 87]

The precise mechanism by which the surgical insult produces the sleep disruption is not completely clear but it is likely that pain plays a major role. Other factors, which may be independent of the surgery and thus account for some of the variability, are neuroendocrine, metabolic and psychological responses, opioid analgesia, and environmental factors such as noise, light and nursing activity.[75 102 105]

The extent to which these changes in sleep architecture after surgery influence morbidity and mortality is currently unknown but there has been considerable speculation based on indirect evidence.[102 104] Patients with REM predominant apnea, for example, might be expected to have an increase in the number and degree of desaturations over a night where REM rebound is occurring[103] but this possibility has been inadequately investigated. Similarly, the occurrence of REM rebound has led to the suggestion that an associated late postoperative increase in nocturnal hypoxaemia could be contributing to mental confusion, wound breakdown, myocardial ischemia and infarction, stroke and death.[34 35 93 98-101] While some relevant associations have been demonstrated direct evidence of causation is lacking.

While anesthesia, of itself, may not effect subsequent sleep once the anesthetic agents are eliminated, a considerable amount of research over the last 20 yr has considered the effects of subanesthetic concentrations on sleep and ventilatory control. Commencing with the work of Knill's group in the 1970s,[64] conflicting results have emerged regarding the effects on ventilatory responses to hypoxia and hypercapnia of subanesthetic concentrations of potent inhalational agents, such as might be present in the minutes to hours after emergence,[33] as well as some other drugs commonly used perioperatively. One reason for these conflicts appears to be the effect of sleep as van den Elsen, Dahan and colleagues have shown that subjects stimulated and kept awake exhibited more or less normal ventilatory responses despite the presence of the potent inhalational agent whereas those allowed to sleep exhibited ventilatory depression.[130 131]

The mechanism by which sleep might contribute to the depression of ventilatory responses by sedative agents has not yet been investigated.

Anesthesia and sleep disordered breathing

Perioperative risks for sleep apnea

Notwithstanding the relative paucity of specific information, knowledge of their physiological effects strongly suggests that anesthetic, sedative and analgesic agents will aggravate or precipitate OSA by decreasing pharyngeal tone, depressing ventilatory responses to hypoxia and hypercapnia and inhibiting arousal responses to obstruction, hypoxia and hypercapnia. These latter effects frequently result in varying degrees of central respiratory depression.

A variety of surgical factors are also contributory. Surgery of the thorax and upper abdomen compromises ventilatory function,[27] [66] potentially compounding the effects of any OSA or centrally mediated hypoventilation that might occur postoperatively. Surgery involving the upper airway carries the risk of postoperative swelling that can worsen or precipitate obstruction.[16] [70] [80] [18] The same applies to situations where the nose is packed or a nasogastric tube is required, as the reduced lumen calibre will necessitate the generation of more negative pharyngeal pressures during inspiration thus promoting collapse.[122] They may also compromise therapy by making nasal CPAP difficult or unusable, and a full-face mask may be required in such circumstances. Patients are frequently nursed supine, sometimes for good reason, and as OSA is often position-dependent this, too, may contribute to increased risk of upper airway obstruction.

To whom might these risks be important?

OSA is common and anaesthetists will often deal with sufferers. There are those who present having already been diagnosed with the disorder. The majority of this group will be on some sort of treatment, usually CPAP, but with a variable degree of compliance.[36] Some will bring their CPAP machines with them to hospital while others will arrive without their equipment, seemingly quite prepared to forego treatment for the duration of their hospital stay. It can reasonably be assumed that many in this latter group are poorly compliant at home. Another group will have been diagnosed with sleep apnea but either declined treatment from the start or failed a trial of therapy.

There are still a large number of people who present for surgery with features suggestive of sleep apnea but who have either never even heard of the condition and/or have not sought diagnosis or treatment. There is also a final group of patients who have apnea but either lack the overt features or have features that are missed perioperatively. Given the high prevalence of OSA in the community, there appears to be little doubt that the number of patients in these last two groups far outweighs the number having already been diagnosed.

Suspected or undiagnosed apnea

Enquiry about snoring and sleep should be a routine component of the preoperative visit. Patients should be asked about common symptoms: heavy snoring with, perhaps, sudden awakenings associated with a choking sensation or similar; witnessed apnea by a bed partner; waking unrefreshed in the morning perhaps even with a headache; excessive daytime sleepiness. These symptoms should particularly be sought in obese patients, middle aged and older patients and in patients with conditions leading to narrowing of the upper airway such as nasal obstruction, tonsillar hypertrophy, or retrognathia.

Where difficult intubation is anticipated the possibility of sleep apnea should also be entertained.[50] The presence of otherwise unexplained respiratory or right heart failure or polycythemia might also point to undiagnosed (and severe) sleep apnea.

In cases of suspected sleep apnea, especially if thought to be severe, deferral of the surgery should be considered to enable investigation and, where indicated, institution of treatment preoperatively. In many instances, the delay this entails would be inconvenient or, in the case of emergency surgery, impossible. Where available and practicable, preoperative consultation with a sleep physician may allow a sleep study to be performed and the problem defined and treated at short notice. If not, perioperative management should be planned on the basis that the patient has the condition, according to the principles outlined in the following section with an intention to refer the patient for definitive investigation at the earliest opportunity.

Anaesthetists are in an excellent position to screen patients for sleep apnea and as it can be associated with substantial morbidity it is a responsibility they should not ignore. A clinical suspicion of sleep apnea may first develop at the preoperative consultation, intraoperatively (if the patient proves difficult to intubate or it is difficult to maintain the airway[50]) or postoperatively with snoring and obstruction observed in the recovery room and/or beyond. These considerations are as important to children as they are to adults, with growth and development potentially compromised by untreated sleep apnoea.[96]

Diagnosed apnea

The preoperative assessment of patients where the diagnosis of sleep apnea has been made should be used to establish the severity of the sleep apnea, mode of treatment, compliance with and complications of treatment, complications of the apnea itself and conditions the patient might have which are the cause of or otherwise associated with the apnea.

OSA is, by definition, an airway problem and its presence may indicate a predisposition to difficulty with intubation or airway maintenance under anesthesia. Severity of sleep apnea may be an important predictor of these difficulties. While there are good theoretical grounds on which to suspect these associations, it is important to note that, at the current state of knowledge, they remain speculative. Prudent anesthetic management is guided by awareness of these possibilities.

The anesthetic management plan is determined by the severity of sleep apnea, how it has been managed prior to anesthesia, the planned surgical procedure and the likely postoperative analgesic requirements.

In the case of mild OSA, managed conservatively (without CPAP) presenting for a simple procedure with little anticipated postoperative discomfort, an anesthetic technique which either avoids unconsciousness or ensures its early recovery together with close observation and nursing in the lateral posture during the early recovery process may be the only specific measures necessary. In contrast, the patient with severe OSA who has substantial analgesic requirements will need close supervision in a high dependency area postoperatively and use of nasal CPAP whenever sedated or otherwise asleep. Such patients particularly may benefit from regional anesthetic and analgesic techniques, the potential benefit increasing with OSA severity, although complications of such techniques have occurred in this setting.[67]

Provision for 'the worst case scenario' of persistent upper airway obstruction should be made even with patients with mild OSA and a breathing circuit capable of delivering CPAP should always be available when the presence of OSA is known or suspected.

Preoperative preparation. Patients with diagnosed apnea who are being treated with CPAP should take their equipment to the operating theatre with them for use postoperatively. These arrangements should be discussed with the patient. There are psychological as well as physiological aspects to consider. While less compliant patients may care little, there are many that are very concerned at the idea that they may stop breathing. The knowledge that their CPAP machine is available is likely to be important to them.

Attending staff must understand the use of the CPAP machine so that they are able to apply it to the patient while he/she is unable to apply it him/herself. While this knowledge may be commonplace amongst the nursing staff of some hospitals it should not be assumed. Staff should be instructed in its use prior to surgery, the patient demonstrating its function if necessary. Hospitals with their own sleep units will have nurses and/or technologists who are familiar with CPAP therapy and able to render assistance where required. This should be established beforehand and the hospital's sleep unit may have CPAP machines available to loan where needed.

It has been argued that sedative premedicants should be avoided in OSA patients.[21] [133] Certainly it is sensible to exercise some care with premedication but in those patients on CPAP there is no real contraindication to even quite heavy premedication as their CPAP may be applied if they get sleepy and oxygen can be added if necessary.[94] It is appropriate to monitor oxygen saturation and for the patient to be observed. An unsupervised holding area is inappropriate for a premedicated sleep apnea patient. If more than light premedication is prescribed then an i.v. cannula should be placed in case antagonists are required urgently. Appropriate antagonists should be immediately available. Some authors have suggested aspiration prophylaxis[21] and the possibility of airway difficulty may justify the use of antisialogogues in these patients.[133]

Intraoperative care. Choice of anesthetic technique is important. The problems of airway maintenance intra- and postoperatively and suppression of arousal responses can be circumvented by use of regional techniques. If the surgical procedure lends itself to them and the patient is otherwise suitable they should be considered, bearing in mind the necessity for airway management should the regional technique result in unconsciousness or respiratory paralysis. If general anesthesia is necessary, then the following considerations apply.

Preparation for a possible difficult intubation should be made along with strategies to manage what may be a difficult airway intraoperatively if the patient is not to be intubated. The choice of induction and maintenance agents is probably not important although it would seem sensible to avoid large doses of longer acting drugs, especially neuromuscular blocking agents. Opioids

should be used judiciously although the availability of CPAP will obviate potential difficulty postoperatively, particularly if the patient is already familiar with it. The issue of familiarity is important, as the early postoperative period is not the ideal environment for introduction of CPAP therapy, particularly if the patient is restless, in pain or hypoxemic.

Postoperative care. In the recovery room and the postoperative ward the patient should be nursed in the lateral posture because of the particular tendency to upper airway obstruction when supine. A nasopharyngeal airway can be a useful aid during emergence.[138] Nasal CPAP should be applied where obstruction persists despite these simple measures.

Oxygen therapy alone is not an adequate treatment of OSA as the issues of recurrent arousals and of carbon dioxide retention remain. The absence of recurrent desaturation may also act to mask the presence of obstructive episodes, particularly in the presence of an inexperienced observer. Oxygen can be added to CPAP treatment. The most economical place to add it is via a side port on the CPAP mask where relatively low flows (2-4 litre min^{-1}) can produce a high F_{IO2}. This addition does not change the CPAP pressure supplied by most modern machines.

The potential problems associated with the use of postoperative sedatives may be circumvented by the use of regional analgesia and/or non-steroidal analgesics or, if opiates are needed, effective use of CPAP.

It is important that the patient with OSA is nursed in the appropriate postoperative environment. This issue is closely related to the patient's analgesic requirements. For the patient who requires CPAP therapy direct supervision is needed while sedated or otherwise asleep until they are capable, unaided, of applying their therapy correctly. This may require admission to a high dependency unit for one or more days postoperatively, particularly for those patients not already familiar with CPAP therapy. On the other hand, patients who recover quickly from general anesthesia and have little narcotic or sedative requirement, or who have good regional analgesia, may be in a position to manage their own CPAP therapy immediately following discharge from the recovery room with no need for special nursing. Where upper airway surgery has been performed, especially in the case of children, high dependency care is warranted. Postoperative swelling has been known to exacerbate apnea after adenotonsillectomy or uvulopalatopharyngoplasty[16 80] and death due to obstruction has occurred after velopharyngeal repair of cleft palate.[70 129] If serious compromise of upper airway patency is anticipated after upper airway surgery then undue reliance on CPAP is inappropriate. The patient may require prolonged tracheal intubation or, where several days or more of airway compromise is anticipated, tracheotomy.

Patients with nasogastric tubes and those having nasal surgery present a special difficulty. The presence of a nasogastric tube does not preclude the application of CPAP as the nasal mask can be applied over the tube, which runs under the mask cushion, but leakage and comfort may be a problem. Patients who have had nasal surgery performed are problematic, particularly if their noses have been packed. A nasopharyngeal airway may be tolerated and it may also be possible to have the surgeon pack the nose around it, although it may have limited calibre. CPAP may need to be applied via a full face rather than nasal mask in such cases.

Summary

Sleep disordered breathing is a common problem affecting all age groups, particularly in association with certain other medical conditions and syndromes. The pathological consequences of the disorder may be severe, with significant implications for the perioperative management of sufferers.

Research into the effects of surgery and anesthesia on sleep is very much in its infancy. Understanding of the implications of sleep disturbance and sleep disordered breathing for perioperative morbidity and mortality is limited. While several observations have led to considerable speculation in the literature, evidence of a causal relationship is still largely lacking.

Anaesthetists are ideally placed to screen large numbers of people for sleep disordered breathing, a source of considerable community morbidity. Recognizing the symptoms, signs and associations of the condition during the preoperative visit is important in planning management, as is recognition of the likelihood of OSA in patients who present difficulty with tracheal intubation or airway maintenance. Particular care is required in the perioperative management of patients with diagnosed or suspected sleep apnea.

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OSA Can Complicate Anesthesia Delivery

Respiratory Therapists and Anesthesiologists Must Be Vigilant

An anesthesia mask looms over the patient undergoing surgery. The glare from the lights overhead dim, and consciousness slips away. Seduced into slumber, his upper airway muscles relax, closing off the passage. He ceases breathing.

If this was a typical night at home in bed, his brain would sense trouble and briefly awaken him to restart his breathing. But as he lies on the operating table, the anesthesia inhibits these arousals, and the amount of oxygen in his bloodstream falls dangerously low.

This scenario demonstrates the risks anesthesia presents for obstructive sleep apnea patients. "Although there have been no clinical trials on anesthesia in sleep apnea patients, clinical experience confirms that anesthesia can be problematic in these patients," according to Christin Engelhardt, executive director of the American Sleep Apnea Association (ASAA).

Yet, with meticulous preparation, careful maintenance of the airway during surgery, and postoperative vigilance, anesthesia can be delivered safely.[1]

Preoperative Assessment

"Not all patients are aware that they suffer from obstructive sleep apnea," says David J. Plevak, MD, associate professor of anesthesiology at the Mayo Clinic, Rochester, Minn. "It's an illness that is not completely appreciated and is underdiagnosed."

Therefore, he stresses that a patient with OSA not undergo elective procedures until a preoperative assessment, including a physical examination and previous history of anesthesia or surgery, is performed. Dr. Plevak suggests several key questions to ask patients:[2]

- Do you snore nightly?
- Has anyone ever said that you stop breathing in your sleep?
- Do you feel tired and groggy on awakening?
- Do you fall asleep easily during the day?

 Do you frequently have headaches in the morning? (However, this symptom is nonspecific.)

"Anesthesiologists have an important role in detecting OSA symptoms," Engelhardt agrees. "By asking patients these questions during pre-surgery screening, they will start to take their symptoms more seriously."

If sleep apnea is suspected, a sleep study may be warranted. Other specialized tests, such as an echocardiogram or pulmonary function tests, can help clarify physical findings that might suggest systemic or pulmonary hypertension, heart failure or impaired oxygenation, all of which are markers of OSA.[2]

Once OSA is recognized, the anesthesiologist will know to use caution when administering sedatives and maintaining proper airway control throughout the surgery.

Postoperative Considerations

This vigilance should continue into the postoperative period, Dr. Plevak says. "Certain medications that patients are given during surgery may be lingering in the immediate post-op period and exacerbate periods of apnea."

CPAP should be used in the recovery room and the pressure monitored because after anesthesia it may need to be increased. In most cases, allowing medications time to be metabolized is all that is necessary. In severe instances, continuing mechanical ventilation in recovery may be required.

"The worst case is that someone be transferred from a monitored area to an unmonitored area and they develop apnea episodes causing a medical emergency. It might lead to patient demise," Dr. Plevak says.

However, several anesthesiologists alerted the ASAA about insurance companies that have refused to allow OSA patients to be kept under the care of medical personnel where they could be monitored appropriately, according to Engelhardt. In response, the ASAA board of directors approved last year a statement on same-day surgery that reads, in part:

"Given the nature of the disorder, it may be fitting to monitor sleep apnea patients for several hours after the last dose of anesthesia and opioids or other sedatives, longer than non-sleep apnea patients require and possibly through one full natural sleep period. Hence there is concern that same-day surgery may not be appropriate for some sleep apnea surgery patients."[3]

The ASAA is hoping respiratory therapists and anesthesiologists will help to increase the recognition of sleep apnea among their patients by thorough screening and will take the necessary steps, including informing hospitals and third-party payors of the precarious relationship between sleep apnea and anesthesia, to provide safe delivery of anesthesia.

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SLEEP APNEA AND SAME-DAY SURGERY

It is well known that sleep apnea* can be a complicating factor in the administration of general anesthesia. It is also known that when the anesthesiologist is aware of the sleep apnea in the patient undergoing surgery and takes appropriate measures to maintain the airway, the risks of administering anesthesia to people with sleep apnea can be minimized.

Although there have been no clinical trials on anesthesia in sleep apnea patients, clinical experience confirms that anesthesia can be problematic in these patients. The cause of potential problems is seen in an anatomic and physiologic understanding of sleep apnea: the syndrome of obstructive sleep apnea is characterized by repetitive episodes of upper airway obstruction during sleep. ("Apnea" literally means "without breath" and is clinically defined as a cessation of breath that lasts at least ten seconds.) Sleep apnea may be accompanied by sleep disruption and arterial oxygen desaturation.

General anesthesia suppresses upper airway muscle activity, and it may impair breathing by allowing the airway to close. Anesthesia thus may increase the number of and duration of sleep apnea episodes and may decrease arterial oxygen saturation. Further, anesthesia inhibits arousals which would occur during sleep. Attention to sleep apnea should continue into the post-operative period because the lingering sedative and respiratory depressant effects of the anesthetic can pose difficulty, as can some analgesics.

Given the nature of the disorder, it may be fitting to monitor sleep apnea patients for several hours after the last dose of anesthesia and opioids or other sedatives, longer than non-sleep apnea patients require and possibly through one full natural sleep period. Hence there is concern that same-day surgery (also known as out-patient or ambulatory surgery) may not be appropriate for some sleep apnea surgery patients.

Before surgery, the anesthesiologist should first conduct a thorough preoperative assessment (including history of anesthesia) and physical examination. The use of preoperative sedatives must be considered carefully as sedative medication, like anesthesia, suppresses upper airway muscle activity. During surgery, maintaining the patency of the airway is the anesthesiologist's primary concern.

The period of awakening from anesthesia after surgery can also be problematic for sleep apnea patients. In patients who have undergone surgery to treat sleep apnea, the airway can be narrowed from swelling and inflammation. There may also be some upper airway swelling secondary to intubation and extubation. As mentioned, the lingering sedative and respiratory depressant effects of the anesthetic can pose difficulty. If narcotics are found to be necessary in the post-operative period, appropriate monitoring of oxygenation, ventilation, and cardiac rhythm should be provided as narcotic analgesics can precipitate or potentiate apnea that may result in a respiratory arrest. Perioperative vigilance must continue into the postoperative period.

Many patients require postoperative intubation and mechanical ventilation until fully awake. Patients who already use a prescribed CPAP (Continuous Positive Airway Pressure) machine should utilize it, but the pressure should be monitored to ascertain that it is adequate. CPAP can also be employed postoperatively in other patients without their own machine to support breathing. For certain patients, it may be judicious to admit them to an intermediate care or intensive care area postoperatively to facilitate close monitoring and airway support measures.

Therefore it is deemed wise to let sleep apnea patients remain in the care of medical personnel until it can be ascertained that their breathing will not be obstructed. While sleep apnea patients may require a longer period of time in the care of medical personnel than would otherwise be required of the surgical procedure, this precaution is prudent and enables anesthesiologists to provide safe anesthetic care for sleep apnea patients.

It should be remembered that **the overwhelming majority of sleep apnea cases have not been identified**. Thus it is not sufficient simply to ask if a patient has sleep apnea. Instead, health care professionals must ask proper screening questions of their patients, especially those individuals at risk for sleep apnea and those children undergoing a tonsillectomy and adenoidectomy, before making decisions on patient care.

For more information about sleep apnea and anesthesia, including screening questions, anesthesiologists can read "Anesthesia Safety Always an Issue with Obstructive Sleep Apnea" by Okoronkwo U. Ogan, MD and David J. Plevak, MD, Anesthetic Patient Safety Foundation Newsletter, Summer 1997 (Volume 12, No. 2, p. 14-15). Also of interest is "Sleep Apnea and Narcotic Postoperative Pain Medication: A Morbidity and Mortality Risk" by Ann Lofsky, MD, Anesthesia Patient Safety Foundation Newsletter, Summer 2002 (Volume 17, No. 2, p. 24-25). "Creation of Observational Unit May Decrease Sleep Apnea Risk", a Letter to the Editor from Jonathon Benumof, MD, appears in the Fall 2002 issue of the Anesthesia Patient Safety Foundation Newsletter (Volume 17, No. 3, p. 39). (A search of the Global Anesthesiology Network entire site, www.gasnet.org, using the term "sleep apnea," may also be beneficial.) Anesthesiologists may also find interesting the article "Perioperative Apnea Diagnosis, Management Deemed Critical" on a presentation given by Jonathon Benumof, MD at Anesthesia Update 2000.

Another interesting article is "Postoperative Complications in Patients With Obstructive Sleep Apnea Syndrome Undergoing Hip or Knee Replacement: A Case-Control Study" by Rakesh M. Gupta, MD, Javad Parvizi, MD, Arlen D. Hanssen, MD, and Peter C. Gay, MD. The researchers conducted a retrospective case-control study of patients having knee or hip replacement surgery and found that, compared to the controls, complications were significantly higher in the sleep apnea group. Further, they found that there was a trend for the untreated OSA patients to have more complications than the treated OSA patients. (Complications were defined as reintubation, acute hypercapnia, episodic desats, arrhythmia, myocardial ischemia or infarction, and delirium.)

Risks of OSA and Anesthesia

Establishing an obstructive sleep apnea protocol in hospitals and educating health care teams at sleep centers regarding the risks associated with OSA and anesthesia can save lives.

Carla Lickteig, BSN, RN, CPAN, and Peter Grigg, MD

On a daily basis, surgical patients are wheeled into operating rooms with unrecognized obstructive sleep apnea (OSA). Diagnosed OSA patients, as well as undiagnosed patients who present with classic signs and symptoms, are at risk for significant post-operative respiratory complications after receiving a general anesthetic and postoperative opiate analgesia.Yet health care providers frequently fail to screen for OSA, and when it is suspected or diagnosed, often fail to incorporate this data into the perioperative plan of care. Nationally, the accumulating cases of respiratory morbidity and mortality in perioperative patients served as the impetus to develop an adult peri-operative OSA protocol at Memorial Hospital, Colorado Springs, Colo.

Approximately 9% of women and 24% of men ages 30 to 60 have a apnea/hypopnea index of ≥5. Additionally, it has been estimated that 80% to 90% of patients with OSA are undiagnosed. Therefore, it became readily apparent that simply screening for patients with a diagnosis of OSA would be remiss, as the majority of patients at risk for OSA would be potentially neglected. Thus, a screening tool was developed based on a literature search and with help from the American Sleep Apnea Association (ASAA) denoting that a presumptive diagnosis of OSA can be made with a history of obesity, habitual snoring, frequent arousal during sleep, and daytime somnolence.[9-11] The screening tool was placed on our preoperative health questionnaire and is completed by the patient. An element of our anesthesiologist perioperative medical examination includes reviewing the Sleep Screening Tool and performing a physical examination searching for stigmata of OSA, such as increased body mass index, hypertension, and signs and symptoms of a difficult airway. A history of habitual loud snoring and a positive response to any of the sleep screening questions accompanied by a positive anesthesiologist interview and examination qualify the patient for Memorial's OSA protocol.

Basis for an OSA Protocol

The basis for the OSA protocol is centered largely on the effects of analgesia and anesthesia on patients with sleep apnea. It is well known that anesthetic, opiate, and sedative agents are central nervous system (CNS) depressants that increase the tendency for upper airway collapse (Figure 1). Additionally, CNS depressants alter the normal ventilatory response to hypercapnia and hypoxemia. Both CNS effects may be significantly worse in OSA patients as the decreased arousal response to breathe leads to prolonged apnea and the potential for respiratory and cardiovascular arrest. Compounding this problem is the technical difficulty of managing the airway, of bag and mask ventilation, and of endotracheal intubation, particularly in a crisis situation on a medical/surgical ward.

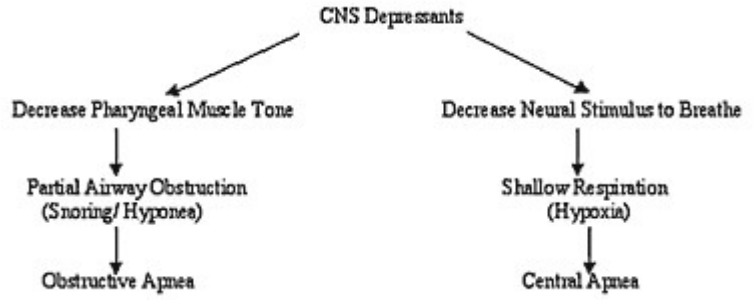

Figure 1. Effects of anesthesia on patients with sleep apnea.

We found our OSA protocol to be an effective risk management tool as evidenced by initial data collected during a trial run of the protocol. Eight of 31 patients experienced postoperative adverse events (AE), defined as apneic periods >10 seconds with O2 desaturation <85%. Of the eight, two patients were previously diagnosed with severe OSA, and the remaining six were screened for OSA and placed at high risk.

The extended monitoring in the post anesthesia care unit (PACU) allowed for identification and treatment of obstructive airway AE that may have proved fatal in an unmonitored environment.

Once on the protocol, the plan of care for each patient is individualized based on the type of surgery and the pain management requirements for the patient. An algorithm (Figure 2) provides a guideline to determine the level of monitoring a patient should have in the postoperative period. In addition, an OSA global policy was developed that delineates the standards of care for the OSA protocol patient. The key to providing the appropriate level of care is to ask whether the OSA patient will require ongoing postoperative opiates (intravenous, intramuscular, or epidural). If the answer is yes, then the OSA patient should be sent to a unit where close observation with continuous monitoring can be employed. Diagnosed patients who use continuous positive airway pressure (CPAP) are encouraged to bring in their own equipment to be used postoperatively. Patients who are placed on the protocol as "high risk" are given a letter with OSA information and recommendation for follow-up at a sleep disorder center, and the patients' primary physician is faxed a copy as well.

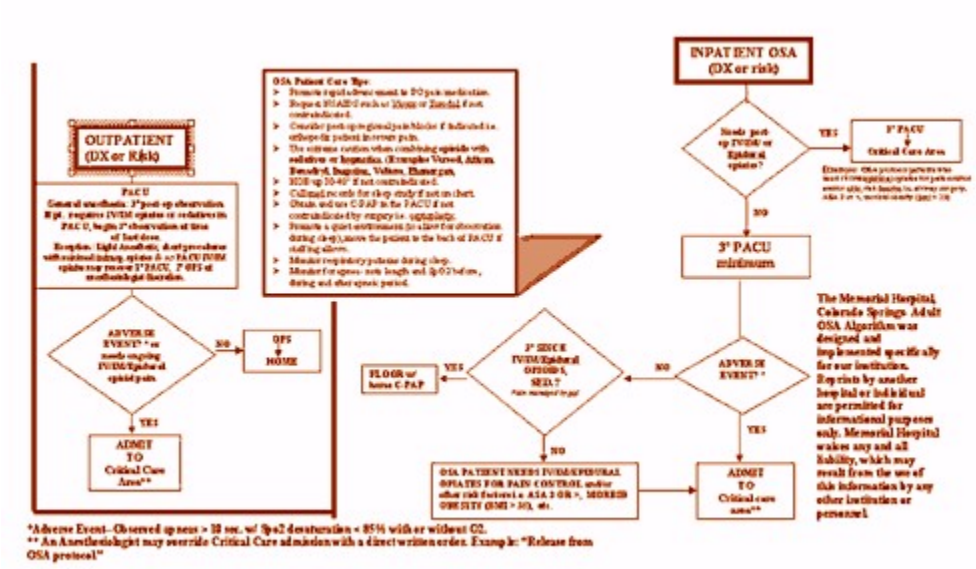

Figure 2. Adult obstructive sleep apnea algorithm at Memorial Hospital, Colorado Springs, Colo.

Currently, we place 50 to 60 patients per month on the protocol and approximately 50% require continuous monitoring in our intensive care unit (ICU). In general, the OSA patient on our protocol is not an "intensive" high acuity patient, so the use of the ICU 1:2 care is not necessary, nor cost-effective, if intermediate monitoring care is available; however, monitoring the patient on a pulse oximeter on the general medical/surgical ward is not likely to be satisfactory[14] so our institution chose to open an intermediate care unit called the monitored surgical care area (MSCA).

The MSCA will be fully operational by spring 2003, and is specifically designed to care for OSA protocol patients as well as other patient populations who require closer monitoring but not intensive care. The nurse patient ratio will be 1:3. Central monitoring consisting of continuous pulse oximetry and electrocardiography with a respiratory lead, and glass-enclosed rooms for close observation will be utilized.

Risk Management Protocol
While our screening tool may be too sensitive, we chose to initiate an OSA risk management protocol that provides safe, effective care in the appropriate setting, rather than risk patient safety. Several future studies are warranted to provide evidence-based guidelines regarding OSA and anesthesia. First, the design, implementation, and validation of a clinical OSA predictor tool are greatly needed (we hope to validate our screening tool in the near future). Second, the design and development of postoperative analgesia protocols that decrease the risk for postoperative apnea and respiratory compromise, and finally, studies on the efficacy of using CPAP on postoperative OSA patients.

Related Issues:

Effects of upper airway anesthesia on pharyngeal patency during sleep

E. L. DeWeese and T. Y. Sullivan Department of Medicine, Indiana University School of Medicine

Pharyngeal patency depends, in part, on the tone and inspiratory activation of pharyngeal dilator muscles. To evaluate the influence of upper airway sensory feedback on pharyngeal muscle tone and thus pharyngeal patency, we measured pharyngeal airflow resistance and breathing pattern in 15 normal, supine subjects before and after topical lidocaine anesthesia of the pharynx and glottis. Studies were conducted during sleep and during quiet, relaxed wakefulness before sleep onset. Maximal flow-volume loops were also measured before and after anesthesia. During sleep, pharyngeal resistance at peak inspiratory flow increased by 63% after topical anesthesia (P less than 0.01). Resistance during expiration increased by 40% (P less than 0.01). Similar changes were observed during quiet wakefulness. However, upper airway anesthesia did not affect breathing pattern during sleep and did not alter awake flow-volume loops. These results indicate that pharyngeal patency during sleep is compromised when the upper airway is anesthetized and suggest that upper airway reflexes, which promote pharyngeal patency, exist in humans.

Anesthesia and the apnea patient

Dr. John Palmeri, M.D., an anesthesiologist who practices at Central DuPage Hospital explained some important considerations for sleep apnea patients undergoing surgical or medical procedures involving anesthesia. This report is adapted with permission from an article published in the monthly newsletter of the A.W.A.K. E. group of Elk Grove Village, Illinois. The article was prepared by Dave Hargett, the newsletter editor and moderator for that group.

Dave is very active in national and regional efforts to educate people about sleep apnea and is an active participant in an online support group, in addition to his local duties. The Newsletter of the Elk Grove Village A.W.A.K.E. group is informative and lively and demonstrates that members receive worthwhile and varied education and support activities.

Our program for the evening was presented by Dr. John Palmeri, an anesthesiologist who practices at Central DuPage Hospital. Dr. Stuart Morgenstein, an ENT specialist who works with our group, recruited Dr. Palmeri to speak after receiving a letter from Dave Hargett. Dave asked several questions about anesthesia and how it impacts the apnea patient. The focus of Dr. Palmeri's talk was to address these questions.

Dr. Morgenstein took the podium to introduce our speaker. Dr. Morgenstein also introduced Dr. Greg Dauber, an oral surgeon, who often works as a "team" member in conjunction with Dr. Hart, Dr. Morgenstein and Dr. Palmeri where surgery is deemed necessary on a sleep apnea patient. Dr. Morgenstein also commented that getting an anesthesiologist to speak isn't easy. They're all very busy people, but he was able to get his first choice to agree to speak to us. Dr. John Palmeri is a member of the Department of Anesthesiology at Central Dupage Hospital, a very talented and gifted anesthesiologist and a caring and committed physician. He also told us that he had warned Dr. Palmeri that we were a sophisticated, aggressive audience.

How can anesthesia impact a person with sleep apnea?

What is the job of the anesthesiologist?

Before addressing the questions that Dave had raised, Dr. Palmeri made some general comments about anesthesia. He pointed out that there is a lot of mystique about what anesthesiologists do. "We're the guys you meet right before surgery -- you never see us again, but you get a big bill from us", a line which drew lots of laughter in agreement.

The purpose of anesthesia is to keep you comfortable during an otherwise noxious procedure -- surgery hurts. The anesthesiologist is there to guarantee your safety and protection during the procedure.

He is also responsible for monitoring your vital signs, heart rate, respiratory rate, oxygen saturation level, and your blood pressure.

Depending on where the surgery is and the type of surgery, there are different ways to achieve the goal of keeping you comfortable. The most common is general anesthesia, which is a means to render the patient unconscious, so that you don't react to or feel your surgery.

The usual procedure is to get you off to sleep with intravenous drugs of a sedative nature. Then you are kept asleep with inhaled gases, administered through a mask over your nose and mouth, or occasionally through an endotracheal tube inserted through the mouth and into the windpipe.

However, it is not always necessary to put you to sleep, depending on the surgery. *(Normal sleep is very different from the 'sleep' induced by anesthesia, which is more like a coma. Ed)*

Frequently, the anesthesiologist just provides sedation to keep you comfortable. For example, with a peripheral procedure or a superficial one, the surgeon can apply local anesthesia to the surgical area so that you can't feel what the surgeon is doing.

The anesthesiologist can then provide sedation so that you're not so aware of what's going on.

Sedation increases the risk of obstruction, especially for people who have sleep apnea

Providing sedation to any patient, though, usually causes some relaxation of the musculature of the pharynx and throat and can cause obstruction. Patients with obstructive sleep apnea tend to be more sensitive to what would otherwise be nonobstructive doses of drugs. It's important for the anesthesiologist to know that you have obstructive sleep apnea (OSA). That's a risk that he should be aware of.

Regional anesthesia

Another way to provide comfort during surgery is regional anesthesia, especially for extremities like arms and legs, and some abdominal procedures. Parts of the body can be numbed without giving any centrally acting drugs.

Narcotics

Normally narcotics are used to relieve pain. Narcotics suppress everyone's drive to breathe. If one has a lower respiratory drive to begin with, narcotics can make that even more dramatic. By numbing just the part of the body being operated on, there is no need to give centrally acting drugs.

Spinal or epidural anesthesia

The most common ways to give regional anesthesia are the "spinal" or the "epidural". Epidural is quite often used to relieve the pain of labor. Many surgeries below the ribcage can be done with epidural. For patients with sleep apnea, this is an especially nice way to work, because it provides comfort and safety without affecting the respiratory drive or the musculature of the pharynx. On the other hand, it does require more cooperation from the patient, as you will be more aware of what's going on. You might hear the pounding of a hammer or the powering up of a drill, for example. While this might be unpleasant, it is an option.

There are risks and benefits in anything you do and in any choices you make, but you can have some control in determining the type of anesthesia depending on the type of surgery.

Talking with the anesthesiologist

Not all anesthesiologists are as sensitive to or aware of the problems associated with sleep apnea patients. Dr. Palmeri urged all of us to make contact with the anesthesiologist before surgery, preferably a day or two before.

Sometimes it isn't practical to meet with the specific anesthesiologist, because the schedule might not be set, but most anesthesiology departments will have someone talk to you about your options and your concerns. Otherwise, it is quite likely (especially with the large number of outpatient or same day surgeries being done today) that you will not meet the anesthesiologist until right before the operation. Working with the anesthesiologist ahead of time lets him try to come up with a plan for attacking your comfort and safety relative to pre-existing problems such as OSA.

The anesthesiologist will try to get a thorough history and do a physical exam before the surgery. In many patients, difficulty with the airway will be detected through this exam. But if you already know about it, such as us OSA patients, be pro-active and raise the issue. Sleep apnea patients often have more difficulty with their airway. It is the anesthesiologist's job to help you breathe while asleep, either with the face mask or the tube. Placing the endotracheal tube into the windpipe can be more difficult with OSA patients, so it is valuable to know this ahead of time to help with selecting the right equipment and strategies.

Using your CPAP while in hospital

Bringing the CPAP to the hospital is an issue Dave asked about. Dr. Palmeri said there was nothing to be lost by doing this, but he saw less need for this for same day surgery compared to surgery that involved an overnight stay. Typically the patient goes from surgery to the recovery room where he/she is closely observed. Problems there are easily handled. However, once back in the hospital room, the vigilance and monitoring is less intense. Having your CPAP there may be useful. He indicated that he had never had a patient use CPAP while in the recovery room. (In later discussion, Dr. Hart indicated that he felt strongly that there should be use of the CPAP in the recovery room.)

Elton Monken raised an issue about the use of his Bi-Pap machine in the hospital after some recent surgery, where the hospital engineering staff came up and inspected his machine in the middle of the night. Dr. Morgenstein pointed out that this is required by the Joint Commission on Hospital Accreditation. He suggested that if we take our CPAP machines to the hospital for possible use, we should ask that they be inspected as soon as possible, so that there is no problem when we want to use them. It is also probably a good idea to have a copy of the prescription covering your prescribed pressure.

Dr. Palmeri also indicated that there are some drugs that they use that can erase memory from the time they are given to you. While under the influence, the patient can have lucid conversations but later have absolutely no recall whatsoever. The patient may think that they were "put under" but they may not have been. (Both Dave Hargett and John Angel described surgeries where such drugs might have been used on them.) However, there is still a need to be careful with sleep apnea patients, as there are differences in tolerance levels among patients.

After surgery

The relief of pain after surgery should also be a concern to us sleep apnea patients. In dealing with post-surgical pain, the most common drugs used are narcotics, either through an IV or a shot. These can be a threat to sleep apnea patients by depressing the drive to breathe. Epidural post-surgical anesthesia can help.

More about epidural anesthesia--how it works and use after surgery

He described epidural anesthesia in more detail. The spinal cord is a cord surrounded by a sac of fluid, and the nerves of the spinal cord come down the midline and at different levels branch out. With epidural anesthesia, a thin, plastic tube called a catheter is inserted through the back, near the spinal cord, and local anesthetic (similar to those used by dentists) is administered to those nerves, blocking the pain. An epidural doesn't actually puncture the sac of fluid surrounding the spinal cord. It sits outside and applies the drugs to nerves as they come out of the spinal cord. This enables the anesthesiologist to numb different parts of the body, usually the lower half. This is normally used for surgery, but once in place can also be used to control post-surgical pain by continuing to administer more dilute solutions of drugs, while avoiding the use of IV drugs that act on the entire body. An epidural is often favored during childbirth because it avoids providing drugs to the baby. A "spinal is usually a one shot deal. The needle goes deeper, drugs are administered, and then the needle comes out. These drugs usually last up to 12 hours.

While many people don't like the idea of having a needle inserted into their back, and many have a fear of paralysis, nerve damage from this type of procedure is actually extremely rare. It is a really practical and safe way to have anesthesia for many procedures. But it does require cooperation from the patient, as the patient is usually awake and aware of what is going on.

Other types of surgery

Surgery above the ribcage almost always requires a general anesthetic.

Some of the new minimally invasive surgeries, where there is no major incision, such as laparascopic hernia repairs, gall bladder surgeries, etc., actually require general anesthesia and intubation because of the way the surgery changes the physiology of the diaphragm and the lungs.

Emergency situations

Since there is always the possibility that the sleep apnea patient could be brought into an emergency room and need surgery, when the patient is unconscious and no one knows about the patient's apnea, the use of a Medic Alert or similar medical warning bracelet or necklace is probably a good idea.

Summary:

- Talk to your anesthesiologist ahead of time. While the final choice of the type of anesthesia will be a team decision between the patient, surgeon and anesthesiologist, and will be based on the circumstances; the patient can have some control over the choice.
- Avoid general anesthesia if you can.
- Avoid the use of narcotics if possible.
- Take your CPAP and prescription to the hospital when you have surgery.
- Have your CPAP inspected by the hospital engineering staff if you anticipate using it.

This is a patient's recollection (aided by a tape recorder) of the talk given to the members of the Elk Grove Village A.W.A.K.E. group on the topic of "Anesthesia and the Apnea Patient". The information is presented here as general background for sleep apnea patients prior to undergoing any surgical or medical procedure requiring anesthesia, but should not be construed as medical advice, since the writer is a sleep apnea patient with no medical degree.

Anesthesia Safety Always an Issue with Obstructive Sleep Apnea

Okoronkwo U. Ogan, M.D.and David J. Plevak, M.D.

Patients with sleep apnea, either obstructive sleep apnea (OSA), central, or mixed sleep apnea, may undergo surgery that necessitates an anesthetic and, because of this disorder, will require special care associated with the anesthestic. Careful and meticulous preparation, which begins with the preoperative assessment and extends into the postoperative period, is the key to safe anesthetic care for these patients.

Of the three types of sleep apnea, OSA is the most common, though anesthesiologists will treat a patient with mixed sleep apnea as they would a patient with OSA. Very few patients have pure central sleep apnea and, in general, patients with central sleep apnea are not of special concern to the anesthesiologist, except under three special circumstances. Those circumstances are first, central sleep apnea with snoring, in which case the patients should be treated as patients with OSA; second, central sleep apnea due to heart failure in which case the precautions for these patients will relate to their underlying heart disease. The third circumstance is central sleep apnea with hypoventilation syndrome; these patients may require unanticipated assisted ventilation during surgery and also post-op.

Factors

An anatomic and physiologic familiarity with OSA is important to understand why anesthesia can be problematic in these patients. The syndrome of OSA is characterized by repetitive episodes of upper airway obstruction during sleep which may be accompanied by sleep disruption, hypoxemia, and arterial oxygen desaturation.

Obstruction or anatomic narrowing can occur at one or more points in the upper airway and may be due to a variety of factors including abnormal neuromuscular tone, redundant soft tissue or an increase in upper airway adipose tissue. Classical OSA patients tend to be obese. However, non-obese patients can have OSA from tonsillar hypertrophy or craniofacial abnormalities. Overtime, recurrent or prolonged arterial oxygen desaturation leads to secondary cardiac and lung abnormalities including systemic and pulmonary hypertension, cardiac rhythm disturbances and, in extreme cases, right ventricular failure which is known as corpulmonale. Therefore, the first step in successfully anesthetizing an OSA patient is to conduct a thorough preoperative assessment.

Preoperative Assessment

The preoperative assessment includes a thorough history and physical examination. As the vast majority of sleep apnea patients are undiagnosed, it is not sufficient to simply ask if the patient has sleep apnea or disturbance. The typical patient with sleep apnea is male, overweight, and over the age of 40, but sleep apnea does occur in both sexes, in thin individuals, and in all age categories.1 Children, particularly those with tonsillar hypertrophy, can also be at risk. Key questions to ask a patient are:

- Do you snore nightly?
- Has anyone ever said that you stop breathing in your sleep?
- Do you feel tired and groggy on awakening?
- Do you fall asleep easily during the day?
- Do you frequently have headaches in the morning? (however, this symptom is non-specific.)

Once the presence of sleep apnea is suspected, the anesthesiologist should ascertain whether the patient has had a previous sleep study and, if so, review the results. If no sleep study has ever been conducted - or if one has been conducted before significant weight gain or another current potentially associated factor - a sleep study may be warranted. The severity of OSA may be learned by questioning the patient regarding the degree of nighttime sleep disruption and daytime sleepiness, but often patients are not aware of their sleepiness or the extent of their nighttime disruption.

Of particular importance is any previous history of anesthesia or surgery. Records should be reviewed for information pertaining to the anesthetic technique employed or any adverse intraoperative or postoperative events. A history of obesity and cardiac or pulmonary disease should be noted.

The physical examination provides an important complement to the historical review. Obesity, particularly upper body obesity which places the patient at risk for OSA, should be noted. The presence of a large neck circumference, even in the non-obese, increases the risk for sleep apnea and should be noted. A formal assessment for the potential difficulty of endotracheal intubation is essential and is usually accomplished utilizing the Mallampati classification of difficult airways.2 Attention is paid to the length and range of motion of the neck, the size of the tongue and teeth, and the presence of any skeletal deformity.

Evaluation of the ability to see into the hypopharynx yields a numerical rating. Examination of the heart and lungs focuses on the presence of physical findings suggestive of systemic or pulmonary hypertension, heart failure or impaired oxygenation. If additional studies are required to clarify the findings on physical examination, specialized tests such as an echocardiogram or pulmonary function studies can be ordered. A general rule is that patients with OSA should not undergo elective procedures until after a thorough preoperative assessment along the lines described here.

Perioperative Considerations

Many patients with OSA are morbidly obese (e.g.: more than two times their ideal body weight). This places them at increased risk for, among other things, aspiration of acidic gastric fluid at the time of induction of anesthesia. It is for this reason that many of these patients receive medications to suppress gastric acid production, to neutralize the acid, or to stimulate emptying of the stomach. Other potential preoperative challenges with patients who are obese can include obtaining adequate reliable intravenous access.

It is customary for anesthesiologists to prescribe sedative medications preoperatively. However, this practice may be problematic for patients with OSA, as they are often sensitive to sedative medications, especially if the OSA is untreated. Even minimal sedation can cause airway obstruction and ventilatory arrest. Therefore, many anesthesiologists do not give preoperative sedatives to patients with OSA.

The most serious perioperative misadventure is the loss of airway control after induction of general anesthesia. Because of reduced oxygen reserve due to obesity-related decreases in lung volume, morbidly obese patients cannot tolerate a lack of ventilation for appreciable periods before hypoxemia results. Tracheostomy (usually emergency cricotyrotomy) can be performed in critical emergency situations to secure the airway. However, the overall results are frequently suboptimal when this procedure is performed in urgent circumstances. It is precisely for this reason that many anesthesiologists prefer to intubate these patients awake, using a fiberoptic laryngoscope. Under certain extreme circumstances, it may be prudent to have an experienced surgeon available in the operating room at the time of induction of general anesthesia in case tracheostomy becomes necessary. An alternative to general anesthesia, particularly for extremity surgery, is regional anesthesia (spinal, epidural, intravenous regional, or peripheral nerve block). Regardless of the primary anesthetic technique chosen, airway maintenance, especially with sedation, remains a fundamental concern to the anesthesiologist.

Postoperative Care

The period of awakening from anesthesia can be problematic for patients with OSA. In patients who have just undergone surgery for the treatment of their OSA, the airway can be narrowed from swelling and inflammation. Also, the lingering sedative and ventilatory depressant effects of the anesthetic can pose difficulty. Perioperative vigilance should continue into the postoperative period. Many patients require postoperative intubation and mechanical ventilation until fully awake. A CPAP (Continuous Positive Airway Pressure) machine can be employed in some patients postoperatively to support breathing.

For certain patients, it may be prudent to admit them to an intermediate care or intensive care area postoperatively to facilitate close monitoring and airway support measures. Narcotic analgesics can precipitate or potentiate apnea that may result in a ventilatory arrest. If narcotics are deemed necessary in the postoperative period, appropriate monitoring of oxygenation, ventilation, and cardiac rhythm should be provided.

Summary

Obstructive sleep apnea patients undergo surgery for a variety of reasons. Airway maintenance issues and frequently associated cardiopulmonary abnormalities place OSA patients at risk for perioperative complications. Safe anesthetic care can be provided by thorough preoperative assessment, a thoughtful and well-executed anesthetic plan, and vigilance which extends well into the postoperative period.

Drs. Ogan and Plevak are from the Department of Anesthesiology, Mayo Clinic, Rochester, Minn.

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The American Sleep Apnea Association serves as a resource for anesthesiologists and their patients. The address is 1424 K Street NW, Suite 302, Washington, DC 20005. Telephone: 202-293-3650. FAX: 202-293-3656 URL: www.sleepapnea.org.

Sleep apnea syndrome

Sleep apnea syndrome is a very common condition but many people are unaware that this condition exists and many cases go untreated. Sleep apnea occurs when a person repeatedly ceases to breathe during sleep. Some episodes last as much as a minute and can cause irreparable damage or even death when left undiagnosed.

There are three types of sleep apnea:

a. Obstructive-this is the most common type and is caused by a blockage of the airway when the soft tissue at the back of the throat collapses

b. Central-the brain is simply not signaling the muscles to breathe

c. Mixed-this is a combination of obstructive and central sleep apnea

Symptoms of sleep apnea may include extremely loud snoring, inability to concentrate, extreme fatigue, depression, daytime sleep attacks, morning headaches, extreme irritability and the psychological results of not experiencing true sleep. Longtime sufferers may also experience high blood pressure, heart irregularities, weight gain and problems with impotence. Most at risk for this ailment are overweight males, 40 years of age or older but women and children also experience sleep apnea. Some scientists believe that there may be a link between sleep apnea and SIDS (sudden infant death syndrome).

Treatments for sleep apnea vary. The first step is to be properly diagnosed. A physician may refer a patient to a sleep specialist who will administer various tests to ascertain the nature of the sleep disorder. This is sometimes done in "sleep labs" so that the patient can be under constant observation during sleep.

After a diagnosis for sleep apnea, surgery may be recommented. In this case, the patient may be at added risk from general anesthesia and must be carefully monitored. During surgery, the effects of respiration being suppressed during anesthesia coupled with the episodes of apnea may present a dangerous situation. For a person diagnosed with sleep apnea, medical personnel must always be notified so that proper precautions can be taken. One-day surgeries are not recommended since the patient may require extended monitoring or medical assistance to recover from the anesthesia.

Often, doctors recommend the CPAP (continuous positive airway pressure) appliance to patients. This machine delivers pressurized air to the nose of the patient to keep airways open during sleep. This air is delivered to the patient through a mask that is worn during sleep. This treatment appliance has been successful reducing or eliminating apnea episodes.

Sleep apnea has been known to cause other psychological and relationship-based problems. The inability to experience true sleep can lead to many undesirable consequences from marriage difficulties to auto accidents caused by sudden sleep attacks and the inability to concentrate.

For those who suspect that sleep apnea may be a problem, a physician should be consulted for a diagnosis. If any serious sleep problems are observed in children, a pediatrician can refer the child to a sleep specialist for a diagnosis.

ANESTHESIA AND THE APNEA PATIENT

The article below is taken from the monthly newsletter of the A.W.A.K.E. group of Elk Grove Village, Illinois. The article was prepared by Dave Hargett, the newsletter editor and moderator for that group. It has been edited slightly from the newsletter version to eliminate extraneous references. This is a patient's recollection (aided by a tape recorder) of the talk given to the members of the Elk Grove Village A.W.A.K.E. group on the topic of "Anesthesia and the Apnea Patient". The information is presented here as general background for sleep apnea patients prior to undergoing any surgical or medical procedure requiring anesthesia, but should not be construed as medical advice, since the writer is a sleep apnea patient with no medical degree

Our program for the evening was presented by Dr. John Palmeri, an anesthesiologist who practices at Central DuPage Hospital. Dr. Stuart Morgenstein, an ENT specialist who works with our group, recruited Dr. Palmeri to speak after receiving a letter from Dave Hargett.

Dr. Morgenstein took the podium to introduce our speaker. Dr. Morgenstein also introduced Dr. Greg Dauber, an oral surgeon, who often works as a "team" member in conjunction with Dr. Hart, Dr. Morgenstein and Dr. Palmeri where surgery is deemed necessary on a sleep apnea patient. Dr. Morgenstein also commented that getting an anesthesiologist to speak isn't easy. They're all very busy people, but he was able to get his first choice to agree to speak to us. Dr. John Palmeri is a member of the Department of Anesthesiology at Central Dupage Hospital, a very talented and gifted anesthesiologist and a caring and committed physician. He also told us that he had warned Dr. Palmeri that we were a sophisticated, aggressive audience.

Before addressing the questions that Dave had raised, Dr. Palmeri made some general comments about anesthesia. He pointed out that there is a lot of mystique about what anesthesiologists do. "We're the guys you meet right before surgery -- you never see us again, but you get a big bill from us", a line which drew lots of laughter in agreement.

The purpose of anesthesia is to keep you comfortable during an otherwise noxious procedure -- surgery hurts. The anesthesiologist is there to guarantee your safety and protection during the procedure. He is also responsible for monitoring your vital signs, heart rate, respiratory rate, oxygen saturation level, and your blood pressure.

Depending on where the surgery is and the type of surgery, there are different ways to achieve the goal of keeping you comfortable. The most common is general anesthesia, which is a means to render the patient unconscious, so that you don't react to or feel your surgery. The usual procedure is to get you off to sleep with intravenous drugs of a sedative nature. Then you are kept asleep with inhaled gases, administered through a mask over your nose and mouth, or occasionally through an endotracheal tube inserted through the mouth and into the windpipe.

However, it is not always necessary to put you to sleep, depending on the surgery. Frequently, the anesthesiologist just provides sedation to keep you comfortable. For example, with a peripheral procedure or a superficial one, the surgeon can apply local anesthesia to the surgical area so that you can't feel what the surgeon is doing. The anesthesiologist can then provide sedation so that you're not so aware of what's going on. Providing sedation to any patient, though, usually causes some relaxation of the musculature of the pharynx and throat and can cause obstruction. Patients with obstructive sleep apnea tend to be more sensitive to what would otherwise be non-obstructive doses of drugs. It's important for the anesthesiologist to know that you have OSA. That's a risk that he should be aware of.

Another way to provide comfort during surgery is regional anesthesia, especially for extremities like arms and legs, and some abdominal procedures. Parts of the body can be numbed without giving any centrally acting drugs. Normally narcotics are used to relieve pain. Narcotics suppress everyone's drive to breathe. If one has a lower respiratory drive to begin with, narcotics can make that even more dramatic. By numbing just the part of the body being operated on, there is no need to give centrally acting drugs.

The most common ways to give regional anesthesia are the "spinal" or the "epidural". Epidural is quite often used to relieve the pain of labor. Many surgeries below the ribcage can be done with epidural. For patients with sleep apnea, this is an especially nice way to work, because it provides comfort and safety without affecting the respiratory drive or the musculature of the pharynx. On the other hand, it does require more cooperation from the patient, as you will be more aware of what's going on. You might hear the pounding of a hammer or the powering up of a drill, for example. While this might be unpleasant, it is an option. There are risks and benefits in anything you do and in any choices you make, but you can have some control in determining the type of anesthesia depending on the type of surgery.

Not all anesthesiologists are as sensitive to or aware of the problems associated with sleep apnea patients. Dr. Palmeri urged all of us to make contact with the anesthesiologist before surgery, preferably a day or two before. Sometimes it isn't practical to meet with the specific anesthesiologist, because the schedule might not be set, but most anesthesiology departments will have someone talk to you about your options and your concerns. Otherwise, it is quite likely (especially with the large number of outpatient or same day surgeries being done today) that you will not meet the anesthesiologist until right before the operation. Working with the anesthesiologist ahead of time lets him try to come up with a plan for attacking your comfort and safety relative to pre-existing problems such as OSA.

The anesthesiologist will try to get a thorough history and do a physical exam before the surgery. In many patients, difficulty with the airway will be detected through this exam. But if you already know about it, such as us OSA patients, be pro-active and raise the issue. Sleep apnea patients often have more difficulty with their airway. It is the anesthesiologist's job to help you breathe while asleep, either with the face mask or the tube. Placing the endotracheal tube into the windpipe can be more difficult with OSA patients, so it is valuable to know this ahead of time to help with selecting the right equipment and strategies.

Bringing the CPAP to the hospital is an issue Dave asked about. Dr. Palmeri said there was nothing to be lost by doing this, but he saw less need for this for same day surgery compared to surgery that involved an overnight stay. Typically the patient goes from surgery to the recovery room where he/she is closely observed. Problems there are easily handled. However, once back in the hospital room, the vigilance and monitoring is less intense. Having your CPAP there may be useful. He indicated that he had never had a patient use CPAP while in the recovery room. (In later discussion, Dr. Hart indicated that he felt strongly that there should be use of the CPAP in the recovery room.)

Dr. Palmeri also indicated that there are some drugs that they use that can erase memory from the time they are given to you. While under the influence, the patient can have lucid conversations but later have absolutely no recall whatsoever. The patient may think that they were "put under" but they may not have been. (Both Dave Hargett and John Angel described surgeries where such drugs might have been used on them.) However, there is still a need to be careful with sleep apnea patients, as there are differences in tolerance levels among patients.

Elton Monken raised an issue about the use of his Bi-Pap machine in the hospital after some recent surgery, where the hospital engineering staff came up and inspected his machine in the middle of the night. Dr. Morgenstein pointed out that this is required by the Joint Commission on Hospital Accreditation. He suggested that if we take our CPAP machines to the hospital for possible use, we should ask that they be inspected as soon as possible, so that there is no problem when we want to use them. It is also probably a good idea to have a copy of the prescription covering your prescribed pressure.

The relief of pain after surgery should also be a concern to us sleep apnea patients. In dealing with post-surgical pain, the most common drugs used are narcotics, either through an IV or a shot. These can be a threat to sleep apnea patients by depressing the drive to breathe. Epidural post-surgical anesthesia can help.

He described epidural anesthesia in more detail. The spinal cord is a cord surrounded by a sac of fluid, and the nerves of the spinal cord come down the midline and at different levels branch out. With epidural anesthesia, a thin, plastic tube called a catheter is inserted through the back, near the spinal cord, and local anesthetic (similar to those used by dentists) is administered to those nerves, blocking the pain. An epidural doesn't actually puncture the sac of fluid surrounding the spinal cord. It sits outside and applies the drugs to nerves as they come out of the spinal cord. This enables the anesthesiologist to numb different parts of the body, usually the lower half. This is normally used for surgery, but once in place can also be used to control post-surgical pain by continuing to administer more dilute solutions of drugs, while avoiding the use of IV drugs that act on the entire body. An epidural is often favored during childbirth because it avoids providing drugs to the baby. A "spinal" is usually a one shot deal. The needle goes deeper, drugs are administered, and then the needle comes out. These drugs usually last up to 12 hours.

While many people don't like the idea of having a needle inserted into their back, and many have a fear of paralysis, nerve damage from this type of procedure is actually extremely rare. It is a really practical and safe way to have anesthesia for many procedures. But it does require cooperation from the patient, as the patient is usually awake and aware of what is going on.

Surgery above the ribcage almost always requires a general anesthetic. Some of the new minimally invasive surgeries, where there is no major incision, such as laparascopic hernia repairs, gall bladder surgeries, etc., actually require general anesthesia and intubation because of the way the surgery changes the physiology of the diaphragm and the lungs.

Since there is always the possibility that the sleep apnea patient could be brought into an emergency room and need surgery, when the patient is unconscious and no one knows about the patient's apnea, the use of a Medic Alert or similar medical warning bracelet or necklace is probably a good idea.

In general summary:

- Talk to the anesthesiologist ahead of time. While the final choice of the type of anesthesia will be a team decision between the patient, surgeon and anesthesiologist, and will be based on the circumstances; the patient can have some control over the choice.
- As a sleep apnea patient, avoid general anesthesia if possible.
- As a sleep apnea patient, avoid the use of narcotics if possible.
- Take the CPAP and prescription to the hospital when having surgery.

Have your CPAP inspected by the hospital engineering staff if you anticipate using it.

Anesthesia and Sleep Apnea Examination

Select the ***best*** answer to each of the following items. Mark your responses on the Answer form.

1. Sleep apnea is of particular concern to anesthetists. The patient with disordered breathing during sleep is likely to also have disturbed breathing when sedated. This effect is compounded by sedation-related compromise of arousal, the mechanism that protects the sleeping patient from life threatening consequences of a breathing disturbance. Furthermore, the upper airway abnormalities that predispose to breathing obstruction during sleep may also make tracheal intubation difficult.

a. True
b. False

2. According to this course, it is generally agreed that an *apnea,* defined as a cessation of airflow, has to exceed 10 s duration to be considered significant.

a. True
b. False

3. Obstructive apneas are characterized by persistent effort without airflow, while with central apnea, effort is absent.

a. True
b. False

4. A narrow, floppy upper airway provides the pathophysiological basis for OSA.

a. True
b. False

5. Unrecognized and untreated, polycythemia and/or respiratory and right heart failure may supervene if sleep related hypoventilation is sufficiently severe. Similar consequences can accompany hypoventilation due to severe OSA.

a. True
b. False

6. The gold standard investigation for sleep apnea is full overnight *polysomnography* (PSG) from which the type and severity of any apnea may be determined.

a. True
b. False

7. Functional residual capacity (FRC) is reduced during sleep, presumably as a consequence of sleep related changes in respiratory muscle tone together with gravitational effects of the supine position on the lung and abdominal contents

a. True
b. False

8. In sleep, apneas or hypopneas can be produced by lowering the PCO_2, as may occur during hypoxic hyperventilation.

a. True
b. False

9. In contrast to sleep, anesthesia is a state of *unrousable* unconsciousness.

a. True
b. False

10. While anesthesia, of itself, may not effect subsequent sleep once the anesthetic agents are eliminated, a considerable amount of research over the last 20 yr has considered the effects of subanesthetic concentrations on sleep and ventilatory control.

a. True
b. False