CLINICAL PRACTICE GUIDELINES

2023

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MANAGEMENT OF OBSTRUCTIVE SLEEP APNOEA

Ministry of Health Malaysia

Academy of Medicine Malaysia

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STATEMENT OF INTENT

This clinical practice guideline (CPG) is meant to be a guide for clinical practice, based on the best available evidence at the time of development. The guideline should not override the responsibility of the practitioners to make decisions appropriate to the circumstances of the individual patient. This should be done in consultation with the patients and their families or guardians, taking into account the management options available locally.

UPDATING THE CPG

This guideline was approved in 2022 and will be reviewed in a minimum period of four years (2026) or sooner if there is a need to do so. When it is due for updating, the Chairperson of the CPG or National Advisor of the related specialty will be informed about it. A discussion will be done on the need for a revision including the scope of the revised CPG. A multidisciplinary team will be formed and the latest systematic review methodology used by MaHTAS will be employed. Every care is taken to ensure that this publication is correct in every detail at the time of publication. However, in the event of errors or omissions, corrections will be published in the web version of this document, which is the definitive version at all times. This version can be found on the websites mentioned above.

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LEVELS OF EVIDENCE

Level	Study design
I	Evidence from at least one properly randomised controlled trial
II-1	Evidence obtained from well-designed controlled trials without randomisation
II-2	Evidence obtained from well-designed cohort or case-control analytic studies, preferably from more than one centre or group
II-3	Evidence from multiple time series with or without intervention; dramatic results in uncontrolled experiments (such as the results of the introduction of penicillin treatment in the 1940s) could also be regarded as this type of evidence
III	Opinions of respected authorities based on clinical experience; descriptive studies and case reports; or reports of expert committees

SOURCE: US / CANADIAN PREVENTIVE SERVICES TASK FORCE 2001

FORMULATION OF RECOMMENDATION

In line with current development in CPG methodology, the CPG Unit of MaHTAS is in the process of adapting **Grading Recommendations, Assessment, Development and Evaluation (GRADE)** in its work process. The quality of each retrieved evidence and its effect size is carefully assessed/reviewed by the CPG Development Group. In formulating the recommendations, overall balances of the following aspects are considered in determining the strength of the recommendations:-

- overall quality of evidence
- balance of benefits versus harms
- values and preferences
- resource implications
- equity, feasibility and acceptability

KEY RECOMMENDATIONS

The following recommendations were highlighted by the CPG Development Group as the key clinical recommendations that should be prioritised for implementation.

OBSTRUCTIVE SLEEP APNOEA (OSA) IN ADULTS

Screening

- STOP-BANG* Questionnaire should be used for screening of adults with clinical suspicion of OSA.
- Epworth Sleepiness Scale (ESS) may be used to assess daytime sleepiness.

* **STOP** - **S**noring, **T**iredness, **O**bserved apnoea and high blood **P**ressure
BANG - **B**MI, **A**ge, **N**eck circumference and **G**ender

Diagnosis

- OSA should be diagnosed using polysomnography (PSG) either level 1, 2 or 3.
- In patient with suspected OSA, the PSG should be performed within six month of initial consultation.
  - Scoring of PSG should be performed by trained medical personnel and its interpretation should be verified by trained specialists.

Treatment

- Lifestyle intervention for weight reduction should be advocated in OSA.
- Positive airway pressure (PAP) therapy should be offered to patients with OSA upon diagnosis especially in moderate to severe OSA.
  - Nasal mask is the preferred interface.
- Upper airway surgery may be considered in selected group of OSA patients.
  - A follow-up PSG may be considered three months after surgery.
- Maxillomandibular advancement may be considered in certain patients with moderate to severe OSA.
- Mandibular advancement appliance may be considered for adult patients with OSA.
  - The preferred design should be tailored to the patient's condition.
- In obese OSA patients (body mass index ≥35 kg/m^2), bariatric surgery may be considered.

General Principles of Perioperative Management of Suspected and Confirmed OSA

- Patients who are at risk of OSA should be screened for OSA preoperatively.
  - The preferred screening tool is STOP-BANG.
- Patient with or suspected high risk of OSA should be monitored closely postoperative.
- Hospitals should have suitable positive airway pressure devices available for perioperative use or ensure patients with OSA bring their own device to the hospital.

Referral

- Patients with clinical suspicion of OSA with or without cardio-metabolic risk factors and STOP-BANG score ≥3 should be referred for diagnostic sleep test.

OBSTRUCTIVE SLEEP APNOEA IN CHILDREN

Diagnosis

- Paediatric Sleep Questionnaire (PSQ) should be used as a screening tool for OSA in children.
- PSG level 1 should be considered for diagnosis of OSA in this group especially those at risk.
  - If it is not available, overnight pulse oximetry may be used as an alternative diagnostic tool.

Treatment

- Oral montelukast and/or nasal corticosteroids may be considered in children with OSA.
- Adenotonsillectomy (AT) is the treatment of choice in children with OSA due to adenotonsillar hypertrophy.
  - In those with post-AT residual disease, upper airway and multilevel obstruction should be reassessed and manage accordingly.
- Continuous positive airway pressure (CPAP) should be offered to children with OSA if they have persistent symptoms or signs after surgery or in whom surgery is contraindicated.
  - Nasal CPAP is the preferred option
  - CPAP should be managed by experienced and skilled multidisciplinary clinicians

Monitoring and Follow-up

- Children with OSA especially the high-risk group should be followed-up by multidisciplinary team trained in sleep medicine.
- Children with OSA who require long-term use of CPAP should be monitored objectively by respiratory paediatrician with paediatric sleep experience.
- Monitoring of CPAP therapy complications is required during follow-up.

SPECIAL GROUP

- Pregnant women with suspected OSA based on symptoms and signs should be referred for further management by a multidisciplinary specialist team.
- Patients with OSA and craniofacial anomalies should be assessed for the benefit and risk of a surgical intervention.
- Patients with Down syndrome should be screened for OSA and treated accordingly.
- CPAP is the preferred initial treatment in stable ambulatory patients with obesity hypoventilation syndrome and severe OSA.

GUIDELINES METHODOLOGY

a. Guidelines Development

The members of the Development Group (DG) for this CPG were from the Ministry of Health (MoH), Ministry of Higher Education and private sector. There was active involvement of a multidisciplinary Review Committee (RC) during the process of the CPG development.

A systematic literature search was carried out using the following electronic databases/platforms: mainly Medline via Ovid and Cochrane Database of Systemic Reviews and others e.g. Pubmed and Guidelines International Network. Refer to **Appendix 1** for **Example of Search Strategy**. The inclusion criterion was patients suspected and diagnosed with OSA. The exclusion criteria were complex sleep apnoea syndrome (e.g. overlap syndrome etc.) and other sleep disorders e.g. narcolepsy, insomnia etc. The search was limited to literature published in the last 10 years, on humans and in English. In addition, the reference lists of all retrieved literature and guidelines were searched and experts in the field contacted to identify relevant studies. All searches were conducted from November 2020 to 31 May 2022. The literature search was repeated for all clinical questions at the end of the CPG development process allowing any relevant papers published before 31 May 2022 to be included. Future CPG updates will consider evidence published after this cut-off date. The details of the search strategy can be obtained upon request from the CPG Secretariat.

References were also made to other guidelines as listed below:

- Treatment of Adult Obstructive Sleep Apnea with Positive Airway Pressure: An American Academy of Sleep Medicine Clinical Practice Guideline (2021)
- Use of polysomnography and home sleep apnea tests for the longitudinal management of obstructive sleep apnea in adults: An American Academy of Sleep Medicine clinical guidance statement (2021)
- Referral of adults with obstructive sleep apnea for surgical consultation: An American Academy of Sleep Medicine clinical practice guideline (2021)
- Evaluation and Management of Obesity Hypoventilation Syndrome: An Official American Thoracic Society Clinical Practice Guideline (2019)
- Clinical Practice Guideline for Diagnostic Testing for Adult Obstructive Sleep Apnea: An American Academy of Sleep Medicine Clinical Practice Guideline (2017)
- Society of Anesthesia and Sleep Medicine Guidelines on Preoperative Screening and Assessment of Adult Patients With Obstructive Sleep (2016)

- Practice guidelines for the perioperative management of patients with obstructive sleep apnea: An updated report by the American Society of Anesthesiologists Task Force on Perioperative Management of patients with obstructive sleep apnea (2014)
- American Academy of Pediatrics: Diagnosis and management of childhood obstructive sleep apnea syndrome (2012)
- Obstructive sleep disordered breathing in 2- to 18-year-old children: Diagnosis and management (2016)
- European Respiratory Society (ERS) statement on obstructive sleep disordered breathing in 1- to 23-month-old children (2017)

The CPGs were evaluated using the Appraisal of Guidelines for Research and Evaluation (AGREE) II prior to being used as references.

A total of 15 main clinical questions were developed under different sections. Members of the DG were assigned individual questions within these sections. Refer to **Appendix 2** for **Clinical Questions**. The DG members met 22 times throughout the development of these guidelines. All literature retrieved were appraised by at least two DG members using Critical Appraisal Skill Programme checklist, presented in evidence tables and further discussed in each DG meeting. All statements and recommendations formulated after that were agreed upon by both the DG and RC. Where evidence was insufficient, the recommendations were made by consensus of the DG and RC. Any differences in opinion were resolved consensually. The CPG was based largely on the findings of systematic reviews, meta-analyses and clinical trials, with local practices taken into consideration.

Literature used in these guidelines were graded using the US/Canadian Preventive Services Task Force Level of Evidence (2001) while the grading of recommendation was done using the principles of GRADE (refer to page i). The writing of the CPG follows strictly the requirements of AGREE II.

On completion, the draft of the CPG was reviewed by external reviewers. It was also posted on the MoH Malaysia official website for feedback from any interested parties. The draft was finally presented to the Technical Advisory Committee for CPG and, the Health Technology Assessment (HTA) and CPG Council, MoH Malaysia, for review and approval. Details on the CPG development by MaHTAS can be obtained from Manual on Development and Implementation of Evidence-based Clinical Practice Guidelines published in 2015 (available at http://www.moh.gov.my/moh/resources/CPG_MANUAL_MAHTAS.pdf?mid=634).

b. Objectives

The objectives of the CPG are to provide evidence-based recommendations on the management of OSA in adults and children based on the following aspects:

a. screening
b. diagnosis and assessments
c. treatment options
d. monitoring and follow-up
e. special groups

c. Clinical Questions

Refer to **Appendix 2**.

d. Target Population

Inclusion Criterion

- All patients suspected and diagnosed with OSA

Exclusion Criteria

- Complex sleep apnoea syndrome (e.g. overlap syndrome etc.)
- Other sleep disorders e.g. narcolepsy, insomnia etc.

e. Target Group/User

This document is intended to guide healthcare professionals and relevant stakeholders in primary and secondary/tertiary care of the management of OSA including:

- doctors and dental surgeons
- allied health professionals
- trainees and medical students
- patients and their advocates
- professional societies

f. Healthcare Settings

Primary, secondary and tertiary care

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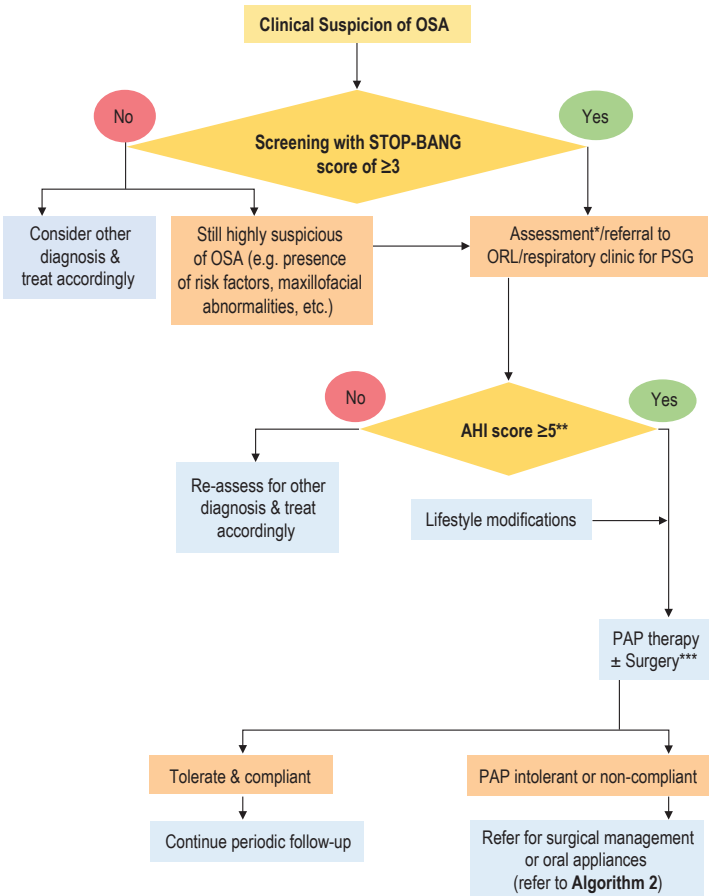
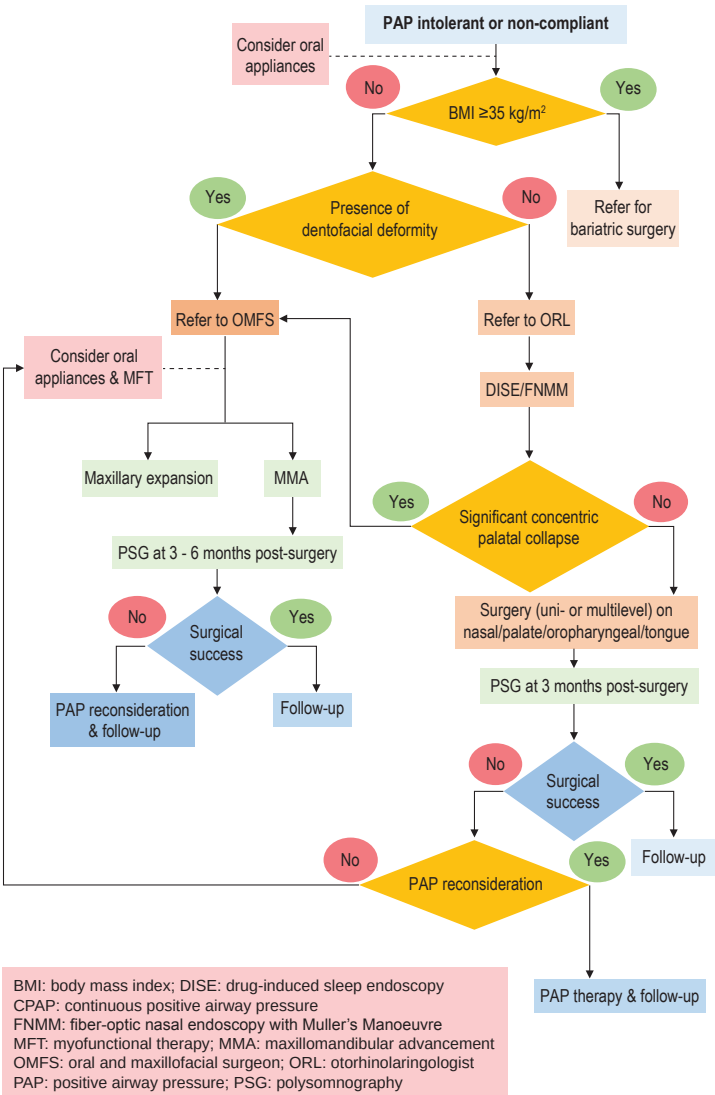
ALGORITHM 1. MANAGEMENT OF OBSTRUCTIVE SLEEP APNOEA IN ADULTS



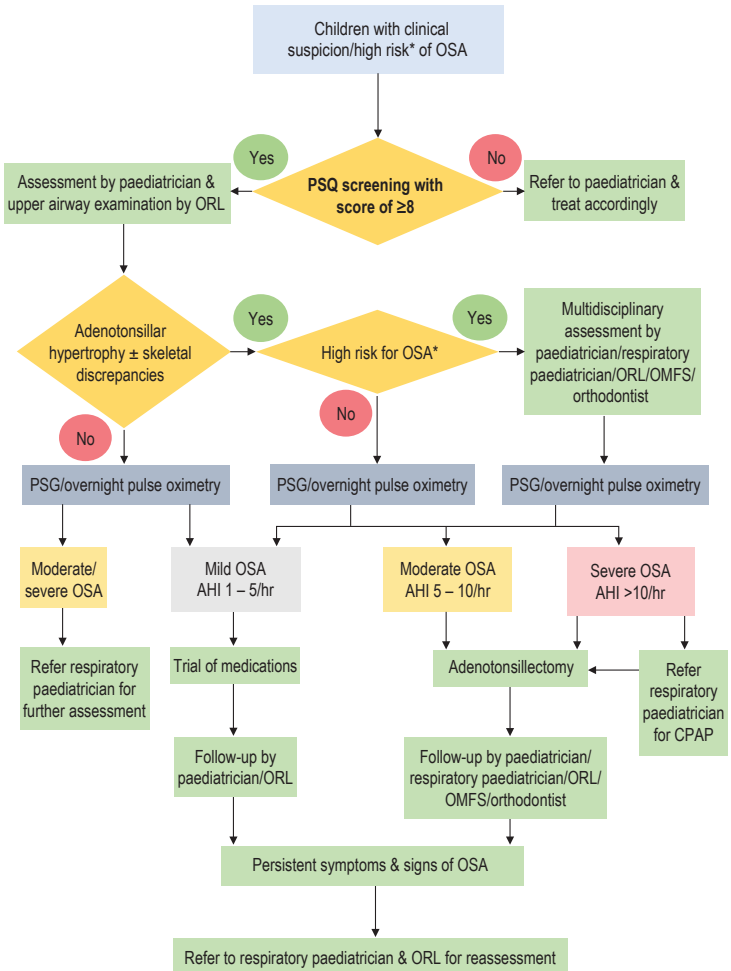
OSA: obstructive sleep apnoea
ORL: otorhinolaryngologist
STOP-BANG: STOP - **S**noring, **T**iredness, **O**bserved apnoea and high blood **P**ressure
BANG - **B**MI, **A**ge, **N**eck circumference and **G**ender
AHI: Apnoea-Hypopnoea Index
PAP: positive airway pressure
*May include endoscopic upper airway evaluation
**Preferably cases of OSA are managed by a multidisciplinary team (certain cases may receive upper airway surgery earlier)
***Patient who opts for surgery should follow **Algorithm 2**

ALGORITHM 2. SURGICAL TREATMENT IN ADULTS WITH OBSTRUCTIVE SLEEP APNOEA



BMI: body mass index; DISE: drug-induced sleep endoscopy
CPAP: continuous positive airway pressure
FNMM: fiber-optic nasal endoscopy with Muller's Manoeuvre
MFT: myofunctional therapy; MMA: maxillomandibular advancement
OMFS: oral and maxillofacial surgeon; ORL: otorhinolaringologist
PAP: positive airway pressure; PSG: polysomnography

ALGORITHM 3. MANAGEMENT OF OBSTRUCTIVE SLEEP APNOEA IN CHILDREN



CPAP: continuous positive airway pressure
OMFS: oral and maxillofacial surgeon
ORL: otorhinolaryngologist
OSA: obstructive sleep apnoea
PSQ: Paediatric Sleep Questionnaire
PSG: polysomnography
*obesity, craniofacial anomalies, Down syndrome etc. (refer to **Subchapter 4.1**)

1. INTRODUCTION

Obstructive Sleep Apnoea (OSA) is a common sleep-related breathing disorder caused by repetitive upper airway collapse resulting in partial or complete breathing cessation. Symptoms include unrefreshed sleep, daytime sleepiness, fatigue, insomnia, awakening with a gasping or choking sensation and loud snoring. Sleep disordered breathing (SDB) and obstructive sleep apnoea syndrome (OSAS) are commonly described as OSA in the literature. For the purpose of this document, we will use OSA as the referring terminology.

This disease affects both children and adults and is associated with significant morbidity. A recent review estimated that nearly one billion adults aged 30 - 69 years worldwide could have OSA. The number of people with moderate to severe OSA in whom treatment was highly recommended was estimated to be at least 425 million.[1, level III] In children, the prevalence of OSA was reported to be up to 5.7%. Obesity was identified as an independent risk factor for OSA in this group.[2, level I] Early recognition and treatment are essential in preventing sequelae from OSA. This medical condition increases all cause and cardiovascular (CV)-related mortality predominantly among the middle-aged group. It is also associated with other co-morbidities including metabolic and cognitive consequences. Therefore, it is important to be aware of the disease and updated with its management.

The management of OSA has evolved since its discovery in 1965, especially after the introduction of Continuous Positive Airway Pressure (CPAP) therapy via nasal mask in 1981 as a form of treatment for OSA. To date, there is no specific local CPG addressing the management of OSA. Thus, it is timely to have the first Malaysian CPG on OSA to guide local healthcare providers in managing this common disorder. It will provide a standard framework for the management of OSA based on the latest evidence available.

2. EPIDEMIOLOGY, RISK FACTORS AND CO-MORBIDITIES

2.1 Epidemiology and Risk Factors

The prevalence of OSA varies due to differences in the definition, diagnostic methods and sociodemographic features. Using American Academy of Sleep Medicine (AASM) 2012 diagnostic criteria, a systematic review estimated that globally 936 million adults aged 30 - 69 years had OSA, in which 45% had moderate to severe disease.[1, level III] In another systematic review, the overall prevalence of OSA ranged from 9% to 38% in adults. Evidence showed that advancing age, male gender and higher body mass index (BMI) increased the prevalence.[3, level III] However, there are no recent local published studies on the prevalence of OSA.

The established risk factors for OSA include:[4]

- age (40 to 70 years old)
- male gender
- family history of OSA
- morbid obesity

Craniofacial features are a risk factor for OSA. The main craniofacial features associated with OSA in adults (based on population of mixed ethnicities) include:

- increased soft palate and tongue thickness[5, level I]
- reduced transverse dimension of the maxilla[6, level III]
- a reduced pharyngeal airway space[5, level I]
- increased vertical skeletal dimensions[5, level I]
- reduced skeletal sagittal dimensions[5, level I]
- a lowered position of the hyoid[5, level I]

2.2 Medical Complications

Patients with OSA are at risk of developing cardio-metabolic complications. A few meta-analyses showed associations between both conditions:

- stroke
  - OR=2.24, 95% CI 1.57 to 3.19[7, level II-2]
  - OR=1.86, 95% CI 1.28 to 2.69[8, level II-2]
- cardiovascular diseases (CVD) (OR=1.71, 95% CI 1.17 to 2.17)[8, level II-2]
- coronary heart disease (CHD) (OR=1.48, 95% CI 1.06 to 2.27)[8, level II-2]
- metabolic syndrome[9, level II-2]
  - OR=2.87, 95 % CI 2.41 to 3.42 in cross-sectional studies
  - OR=2.56, 95 % CI 1.98 to 3.31 in case-control studies

The quality of primary studies in two of the meta-analyses were moderate.[7 & 9, level II-2]

Other medical conditions associated with OSA as shown in meta-analyses were:

- asthma (OR=2.64, 95% CI 1.76 to 3.52)[10, level III]
- non-alcoholic fatty liver disease with[11, level III]
  - abnormal histopathological examination (HPE) findings (OR=2.01, 95% CI 1.36 to 2.97)
  - abnormal radiological findings (OR=2.99, 95% CI 1.79 to 4.99)
  - aspartate aminotransferase (AST) elevation (OR=2.36, 95% CI 1.46 to 3.82)
  - alanine transaminase (ALT) elevation (OR=2.60, 95% CI 1.88 to 3.61)
- chronic kidney disease (CKD) (RR=1.85, 95% CI 1.32 to 2.59)[12, level III]
- all type of cancer[13, level II-2]
  - mild OSA (RR=1.14, 95% CI 1.04 to 1.25)
  - moderate OSA (RR=1.36, 95% CI 1.24 to 1.50)
  - severe OSA (RR=1.59, 95% CI 1.45 to 1.74)
- cognitive impairment (RR=1.26, 95% CI 1.05 to 1.50)[14, level II-2]

Only one meta-analysis reported good quality of the primary papers.[11, level III]

Two systematic reviews found associations between OSA and:

- chronic obstructive pulmonary disease (COPD)[15, level II-2]
- major depressive disorder and post-traumatic stress disorder[16, level III]

In a large, multinational cross-sectional study on subjects undergoing assessment of suspected sleep-disordered breathing, the diagnosis and severity of OSA was associated with an increased likelihood of a concomitant diagnosis of T2DM. The risk of T2DM increased significantly as OSA severity increased i.e. 1.33 (95% CI 1.04 to 1.72) in mild, 1.73 (95% CI 1.33 to 2.25) in moderate and 1.87 (95% CI 1.45 to 2.42) in severe OSA ($p<0.001$ for trend).[17, level III]

Recommendation 1

- Medical conditions* associated with obstructive sleep apnoea should be identified and treated accordingly.

*Refer to preceding text in **Subchapter 2.2**

3. OBSTRUCTIVE SLEEP APNOEA IN ADULTS

3.1 Screening

Adult patients with OSA can present with both daytime and night-time symptoms as shown below:

Daytime symptoms	Night-time symptoms
• Excessive daytime sleepiness • Unrefreshed sleep • Tiredness/fatigue • Early morning headache • Dry mouth • Poor attention/concentration span • Memory impairment • Mood disturbance or irritability • Decrease libido/erectile dysfunction	• Snoring • Witnessed apnoea (cessation of breathing) • Gasping/choking • Nocturia • Difficulty initiating and maintaining sleep • Fragmented sleep (frequent wakening)

The clinical findings of OSA may include raised blood pressure, large neck circumference, obesity and crowded oropharynx [modified Mallampati grade 3 and 4 (refer to **Appendix 3** on Modified Mallampati), micro/retrognathia, high arch palate, enlarged tonsils (refer to **Appendix 4** on Tonsillar Grading), macroglossia].

Screening tools are useful to detect patients at risk for OSA. Early detection will lead to early referral and also prioritisation of patients who may need a diagnostic tool e.g. an overnight polysomnography (PSG) to confirm the diagnosis.

Several screening tools have been widely used in the adult population e.g. the Berlin Questionnaire (BQ) (**Appendix 5**), STOP-BANG Questionnaire (SBQ) (refer to **Appendix 6** and **7**), STOP Questionnaire (SQ) and Epworth Sleepiness Scale (ESS) (**Appendix 8**).

A meta-analysis found that the sensitivity and diagnostic odds ratio (DOR) of the SBQ were higher than those of the BQ, SQ and ESS in detecting mild, moderate and severe OSA. However, the specificity of SBQ was lower compared with ESS. Hence the study concluded that the SBQ was superior in the detection of various severity of OSA in adults compared with the others. The pooled sensitivity and specificity are shown in **Table 1**.[18, level III] The primary papers included were of mixed quality.

Table 1. Pooled sensitivity and specificity of different screening tools for OSA

Questionnaire	Description	Severity of OSA	Pooled Sensitivity	Pooled Specificity
Berlin Questionnaire (Appendix 5)	10 items grouped in 3 categories: • symptoms of snoring and cessation of breathing • symptoms of excessive daytime sleepiness • presence of hypertension with additional information on height and weight High risk: positive score in 2 or more categories	AHI>5	76%	59%
		AHI>10	76%	44%
		AHI>15	84%	38%
STOP-BANG Questionnaire (refer to **Appendix 6** and **7**)	4 subjective and 4 demographic items: • STOP - Snoring, Tiredness, Observed apnoea and high blood Pressure • BANG - BMI, Age, Neck circumference and Gender *High risk of OSA: Yes to 3 or more questions* *Low risk of OSA: Yes to less than 3 questions*	AHI>5	88%	42%
		AHI>10	90%	36%
		AHI>15	93%	35%
STOP Questionnaire	4 items consisting of yes/no answers: STOP - Snore, Tiredness/fatigue, Observed stopped breathing and high blood Pressure High risk: 2 or more 'yes' answer	AHI>5	87%	42%
		AHI>10	89%	32%
		AHI>15	90%	28%
Epworth Sleepiness Scale (**Appendix 6**)	8 items measuring the likeliness of daytime sleepiness in different situations, the score ranges from 0 - 24. High risk: score 11 or more	AHI>5	54%	65%
		AHI>10	47%	62%
		AHI>15	58%	60%

AHI=Apnoea Hypopnoea Index

A recent meta-analysis evaluating the diagnostic accuracy of various screening tools in different clinical cohorts supported the above findings and concluded that SBQ had the highest sensitivity to detect OSA with highest diagnostic OR in sleep clinic and surgical populations but lacked specificity.[19, level III] The quality of the primary papers included were moderate.

This is further supported by another systematic review using subjects mostly from sleep clinic populations. The review found the highest sensitivity rates for SBQ in the prediction of mild and severe OSA (97.55% and 98.7% respectively) while the highest specificity rate was for BQ (90% and 80% respectively). For predicting moderate OSA, SQ had both the highest sensitivity (100%) and specificity (92.3%).[20, level III] However, the quality assessment on the primary papers included was not reported.

In the era of digital technology, the use of mobile technology and novel tools has the potential to aid in the screening and diagnosis of OSA. A meta-analysis evaluating the accuracy of smartphones and portable devices in screening for OSA found that bed or mattress-based devices and contactless devices had the greatest potential for use in screening and possibly monitoring OSA. They had the best overall sensitivity of 0.921 (95% CI 0.870 to 0.953). The overall sensitivity of contactless devices to detect OSA was 0.905 (95% CI 0.839 to 0.946). The contactless devices used various mechanisms including respiratory and body movement obtained either from emission of sound waves, emission of low-power radiofrequency energy or use of a piezoelectric sensor, photograph images and speech recordings. However, due to lack of studies comparing the new tools with gold standard method (PSG), more evidence is needed before recommendations can be made for these devices in clinical use.[21, level III] The included primary papers were of mixed quality.

Recommendation 2

- STOP-BANG* Questionnaire should be used for screening of adults with clinical suspicion of obstructive sleep apnoea.
  - Epworth Sleepiness Scale may be used to assess daytime sleepiness.

* **STOP** - **S**noring, **T**iredness, **O**bserved apnoea and high blood **P**ressure
BANG - **B**MI, **A**ge, **N**eck circumference and **G**ender

3.2 Diagnosis

- OSA is suspected in the presence of clinical signs and symptoms, and a positive screening questionnaire. The diagnosis can only be confirmed by PSG (level 1, 2 or 3).

The diagnosis of OSA cannot be made solely based on clinical signs or symptoms identified during sleep-oriented history and physical examination. They need to be supported by PSG or home sleep apnea testing (HSAT).[22]

OSA is diagnosed through PSG. There are four levels of sleep test as described in **Table 2**. Only level 1 - 3 can be used for diagnostic purposes, whilst level 4 is used for screening.

Table 2. Different level of sleep testing

Parameter	Level 1	Level 2	Level 3	Level 4
Description	Full attended PSG	Full unattended PSG	Portable monitor (Partial PSG/HSAT)	Continuous single or dual bio-parameter
Measures	Minimum of seven channels: EEG, EOG, EMG, ECG, airflow, respiratory effort, O_2 saturation	Minimum of seven channels: EEG, EOG, EMG, ECG, airflow, respiratory effort, O_2 saturation	Minimum of four channels (two respiratory effort and airflow, heart rate (HR)/ECG, O_2 saturation)	Minimum of one channel: O_2 saturation, respiratory effort
Body position	Measured	Measured	Can be measured	Not measured
Leg movement	Measured	Measured	Not measured	Not measured
Personnel	Attended	Unattended	Unattended	Unattended

Adapted: Hesselbacher SE, Mattewal A, Hirshkowitz M et al. Classification, Technical Specifications, and Types of Home Sleep Testing Devices for Sleep-Disordered Breathing. Sleep Med. Clin. 6 (2011):261-282.

In the standard PSG, Apnoea-Hypopnoea Index (AHI) is defined as apnea+hypopnea/total sleep time while the AHI in the portable monitor (PM) is the number of apneas+hypopneas/total recording time. As a result, PM are likely to underestimate the severity of respiratory events compared with PSG.

The other disadvantages of PM include its inability to evaluate the quality of sleep and other non-respiratory sleep disorders. HSAT and PM have the advantage that the patient sleeps in his/her own bed, thus the sleep pattern may be more representative of everyday sleep. PM reduces health-care costs and waiting times, thus making the diagnosis of OSA accessible to centres that do not have conventional PSG.

The following are recommended for a diagnosis of OSA in adults:[22]

- PSG or HSAT can be used in uncomplicated cases presenting with signs and symptoms of OSA with an increased risk for moderate to severe disease.
- PSG should be performed if a single HSAT is negative, inconclusive or technically inadequate.
- Full attended PSG (level 1) should be used for patients with significant cardiorespiratory disease, potential respiratory muscle

weakness due to neuromuscular condition, awake hypoventilation or suspicion of sleep-related hypoventilation, chronic opioid medication use, history of smoking or severe insomnia,

- A second PSG may be considered if the initial PSG is negative and clinical suspicion for OSA remains.

- Diagnostic criteria for adult OSA[23]
  (A and B) or C satisfy the criteria
  A. The presence of one or more of the following:
     1. The patient complains of sleepiness, non-restorative sleep, fatigue or insomnia symptoms
     2. The patient wakes with breath holding, gasping or choking
     3. The bed partner or other observer reports habitual snoring, breathing interruptions or both during the patient's sleep
     4. The patient has been diagnosed with hypertension, a mood disorder, cognitive dysfunction, coronary artery disease, stroke, congestive heart failure, atrial fibrillation or type 2 diabetes mellitus
  B. PSG or out-of-centre sleep testing (OCST) demonstrates:
     1. ≥5 predominantly obstructive respiratory events [obstructive and mixed apnoeas, hypopnoeas or respiratory effort-related arousals (RERAs)] per hour of sleep during a PSG or per hour of monitoring (OCST)

OR

  C. PSG or OCST demonstrates:
     1. ≥15 predominantly obstructive respiratory events (apnoeas, hypopnoeas or RERAs) per hour of sleep during a PSG or per hour of monitoring (OCST)

- The third edition of the International Classification of Sleep Disorders (ICSD)-3 defines OSA as:[23]
  - AHI ≥5/hour associated with the typical symptoms of OSA or associated medical/psychiatric disorder
  - AHI ≥15/hour (even in the absence of symptoms or disorders)

Sleep testing or PSG is a test to evaluate various types of sleep disorders and not just OSA. Ideally, PSG should be done either at night (overnight) or during the subject's usual sleep schedule, with a recording of no less than 6.5 hours, including at least three hours of sleep. A diagnosis of OSA can still be made even if the recording is less than the ideal hours provided that it is interpreted by a sleep specialist.

In a meta-analysis on diagnostic accuracy of 19 high quality studies, level 3 portable sleep tests when compared with level 1 PSG showed a good diagnostic performance in adult with uncomplicated OSA and no

unstable co-morbidities. The ROCs were high, ranging between 0.85 and 0.99 across different levels of disease severity.[24, level III]

Another meta-analysis on the diagnostic accuracy of level 4 portable sleep monitors vs PSG for OSA showed that the diagnostic accuracy of type 4 portable monitoring varied depending on the type of device, number of channels and disease severity.[25, level III]

In a systematic review on the value of oxygen desaturation index (ODI) with reference to AHI among predominantly middle-aged men without co-morbidities, the sensitivities of ODI ranged from 32% to 98.5%, whereas specificities ranged from 47.7% to 98% in the diagnosis of OSA. Studies reported data for a 4% ODI ≥15/hour showed an improved specificity for diagnosing OSA which ranged from 75% to 98%. Thus, consideration should be given for diagnosing adult OSA with a 4% ODI of ≥15/hour. However, the quality of the primary papers were poor with large discrepancies in the definitions of almost all of the variables used in the studies.[26, level III]

Digital health using smart phones and portable devices had been studied to diagnose OSA. A meta-analysis with mixed quality of primary papers on sleep-related breathing disorder showed that bed/mattress-based devices had the best overall sensitivity of 0.921 (95% CI 0.870 to 0.953). On the other hand, contactless devices can detect mild OSA with a sensitivity of 0.976 (95% CI 0.899 to 0.995).[21, level III]

The CPG DG opines that in patient with suspected OSA, the PSG should be performed within six month of initial consultation. Scoring of PSG should be performed by trained medical personnel and its interpretation should be verified by trained specialists.

Severity of OSA in adults are shown as below:

AHI	Severity of OSA
<5/hr	No OSA
5-15/hr	Mild
15-30/hr	Moderate
>30/hr	Severe

Recommendation 3

- Obstructive sleep apnoea (OSA) should be diagnosed using polysomnography (PSG) either level 1, 2 or 3.
- In patient with suspected OSA, the PSG should be performed within six month of initial consultation.
  - Scoring of PSG should be performed by trained medical personnel and its interpretation should be verified by trained specialists.

- **Upper Airway Assessment**

Upper airway assessment is important in deciding the best surgical approach to treat OSA. Fiber-optic nasal endoscopy with Muller's Manoeuver (FNMM) has been used as a method to assess upper airway obstruction. Drug-induced sleep endoscopy (DISE) has recently been introduced for such assessment. However, it requires deep sedation and involvement of anaesthetists, and thus may pose challenges in carrying out the procedure in the local setting. Three cross-sectional studies showed that there were discrepancies between FNMM and DISE findings in the degree of obstruction. There were significant differences in the detection of retrolingual collapse identified via DISE compared with FNMM.[27 - 29, level III]

The CPG DG opines that DISE is more accurate than FNMM in determining the degree of upper airway obstruction prior to sleep surgery based on case series.

- If DISE is unable to be performed prior to surgery, FNMM may still be offered as an alternative procedure to identify the level and degree of obstruction.

3.3 Treatment

Management of adult OSA patients include lifestyle modification, weight management, PAP therapy, oral appliance therapy and surgical procedures. Delivery of quality treatment for OSA patients require a multidisciplinary approach. Communication among team members is essential for effective and holistic OSA management.

a. Weight Management and Lifestyle Modification

Obesity is strongly associated with OSA[3, level II-2] and there is a potential reciprocal role of OSA in obesity.[30, level III] Thus, weight management and lifestyle modification is an important treatment either as an adjunct to other treatment or alone i.e. bariatric surgery in OSA with obesity.

Three meta-analyses showed that lifestyle intervention which include diet, exercise or combination of both, improved both AHI and BMI in adults with OSA.

- In the first meta-analysis weight loss through diet and/or physical activity decreased AHI compared with control (WMD= -6.04/hour, 95% CI -11.18 to -0.90). However, diet alone did not show any significant difference in the outcome.[31, level I]
- The second meta-analysis also supported the finding where intensive lifestyle interventions reduced weight (WMD= -13.76 kg, 95% CI -19.21 to -8.32) and improved both AHI (WMD= -16.09/hour, 95% CI -25.64 to -6.54)) and ODI (WMD= -14.18, 95% CI -24.23 to -4.13).[32, level I]

- In the recent meta-analysis, combination of diet and exercise improved AHI (WMD= -8.09/hour, 95% CI -11.94 to -4.25) and BMI (WMD= -2.41 kg/m2, 95% CI -4.09 to -0.73). Apart from that, diet alone improved both AHI (WMD= -8.61/hour, 95% CI -15.89 to -1.33) and BMI (WMD= -3.97, 95% CI -5.77 to -2.18), while exercise alone only improved AHI (WMD= -8.08/hour, 95% CI -15.78 to -0.42) but not BMI.[33, level I]

The primary papers in the meta-analyses were generally of moderate quality.

Recommendation 4
- Lifestyle intervention for weight reduction should be advocated in obstructive sleep apnoea.

b. Positive Airway Pressure Therapy

Positive airway pressure (PAP) therapy has become the primary therapy to treat adults with OSA across the spectrum of disease severity.

- PAP therapy refers to the delivery of compressed air which splints the collapsed upper airway.
  - It is the gold standard treatment for OSA.[34]
  - Two types of PAP therapy are continuous PAP (CPAP) and bi-level PAP (BiPAP). Both can be automated (APAP) or fixed pressure.

A meta-analysis showed improvement in physical QoL of patients with OSA who had received CPAP compared with controls. However, there were no significant difference in overall and psychological QoL[35, level I]

i. Positive Airway Pressure Therapy and its effect on co-morbidities

CPAP was effective in prevention of stroke in OSA as reported in a meta-analysis. Cohort studies demonstrated significant effectiveness (OR=0.590, 95% CI 0.350 to 0.994). Although RCT result was non-significant on effectiveness, subgroup analysis showed stroke reduction with good CPAP adherence (>4 hours and at least 70% of usage days) and moderate to severe OSA with OR of 0.530 (95% CI 0.323 to 0.86) and 0.505 (95% CI 0.260 to 0.979) respectively. The primary papers included were mostly low risk of bias.[36, level I]

In another meta-analysis on the prevention of CV events in patients with OSA, CPAP therapy did not improve CV outcomes e.g. stroke, atrial fibrillation, myocardial infarction and unstable angina. The findings need to be taken with caution due to risk of bias of the included studies.[37, level I]

Despite unfavourable findings on most major adverse cerebrovascular and CV endpoints (MACEs), CPAP therapy in OSA had been shown to be effective in improving arterial stiffness measured by pulse wave velocity (a marker of vascular damage and an independent predictor of CV morbidity and mortality) compared with control (MD= -0.44, 95% CI -0.76 to -0.12). The included studies in the meta-analysis had moderate risk of bias.[38, level I]

In patients with OSA and resistant hypertension, a meta-analysis showed that CPAP therapy was associated with clinically significant changes in 24-hour systolic blood pressure (SBP) (MD= -5.06 mmHg, 95% CI -7.89 to -2.13) and 24-hour diastolic blood pressure (MD= - 4.21 mmHg, 95% CI -6.5 to -1.93). The quality of the evidence was moderate or low for most outcomes.[39, level I] CPAP therapy was more effective in treating resistant hypertension than nonresistant hypertension in OSA as shown in a systematic review.[40, level I]

A meta-analysis looking at CPAP therapy among patients with OSA and depression showed significant improvement in psychological symptoms especially those who used the therapy for >4 hours/night compared with controls.[41, level I] Most of the studies included were of moderate quality.

ii. Automated vs fixed-continuous positive airway pressure

A meta-analysis of 24 RCTs showed that automated PAP (APAP) had increased compliance compared with fixed-CPAP in OSA (MD=0.18 hours/night, 95% CI, 0.05 to 0.31). However, there was no significant difference in AHI reduction. The side effects (SEs) reported were dry mouth, air leakage and skin or nasal-oral irritation. There was no significant difference in SEs reported in five RCTs comparing APAP with fixed CPAP.[42, level I] The quality of the primary papers in the meta-analysis was moderate.

However, in a recent meta-analysis, there was no significant difference in adherence between APAP and fixed-CPAP.[43, level I]

The findings of a recent Cochrane systematic review comparing APAP and fixed-CPAP in adults with moderate to severe OSA were:[44, level I]

- APAP increased machine usage by 13 minutes/night (MD=0.21 hours/night, 95% CI 0.11 to 0.31) and reduced daytime sleepiness based on Epworth Sleepiness Scale (ESS) by a small amount (MD= -0.44 units, 95% CI -0.72 to -0.16) at six weeks; however, the reduction in ESS was not clinically significant.
- fixed-CPAP had slightly lower AHI values (MD=0.48/hour, 95% CI 0.16 to 0.80)

Adverse events (AEs) reported were nasal blockage, dry mouth, pressure intolerance and mask leak. The tolerability outcome could not be compared between the two modalities due to different variables

measured. The quality of the primary papers in the review was of moderate to high certainty.

iii. Interface

CPAP delivery interface includes nasal, intra-nasal (nasal-pillow) and oronasal masks.

In a small Cochrane systematic review, the optimum form of CPAP delivery interface remained unclear due to the limited number of studies.[45, level I]

Nasal mask showed no significant difference in adherence with nasal pillow or oronasal mask in meta-analyses of RCTs.[43, level I]

According to the 2020 American Thoracic Society Workshop report, nasal mask should be the initial option for most patients.[46, level III]

iv. Bi-level Positive Airway Pressure

Indications to switch from CPAP to BiPAP are when:[47]

- patient complains of being uncomfortable or intolerant to high CPAP pressures
- CPAP level is ≥15 cm H_2O and respiratory disturbances continue

c. Education, Supportive and Behavioural Interventions

A Cochrane systematic review compared the use of educational, supportive, behavioural or mixed (combination of two or more intervention types) strategies with control in encouraging compliance of CPAP usage in adults with OSA. Supportive interventions included office or/and home-based visits or phone check-ins by clinical staff while behavioural interventions included psychotherapeutic techniques. The findings showed that CPAP usage increased with:[48, level I]

- behavioural intervention (MD=1.31 hours/night, 95% CI 0.95 to 1.66)
- supportive intervention (MD=0.7 hours/night, 95% CI 0.36 to 1.05)
- educational intervention (MD=0.85 hours/night, 95% CI 0.32 to 1.39)
- mixed intervention (MD=0.82 hours/night (95% CI 0.2 to 1.43)

The primary papers were of varied quality.

According to AASM guidelines, telemonitoring intervention has been shown to improve adherence.[34]

Recommendation 5

- Positive airway pressure (PAP) therapy should be offered to patients with obstructive sleep apnoea (OSA) upon diagnosis especially in moderate to severe OSA.
  - Nasal mask is the preferred interface.

c. Surgery

PAP therapy is the mainstay treatment for OSA, however any major structural upper airway obstruction should be treated accordingly. Surgical treatment for OSA is one of the treatment options in selected group of patients. Surgery is part of continuous care for OSA patients who do not tolerate or accept PAP therapy.[49] It is also indicated to increase PAP compliance in patients with major structural upper airway obstruction.

In deciding the benefits of surgery, surgical success and surgical cure have been used. Surgical success in OSA is defined as postoperative reduction in the AHI of 50% and/or a postoperative AHI of <20 event/hour[54, level II-3] whilst surgical cure is defined as an AHI of <5 events/hour after any sleep surgery.

The CPG DG opines that follow-up PSG should be performed three months after surgery for reassessment.

i. Nasal surgery

Nasal breathing is vital for better quality sleep. A non-randomised clinical trial showed that combining nose surgery in multilevel surgery improved surgical success compared with multilevel surgery without nose surgery in OSA (OR=1.8, 95% CI 1.3 to 2.7).[50, level II-1]

Evidence from an earlier meta-analysis with moderate quality of primary papers showed that isolated nasal surgery in patients with OSA and nasal obstruction reduced therapeutic CPAP device pressures compared with baseline (MD= -2.66 cmH2O, 95% CI -3.65 to -1.67).[51, level II-3]

Upper airway surgery may have a moderate effect on decreasing therapeutic PAP requirements (i.e. optimal PAP level) and increasing PAP adherence although this estimate is based on a small number of uncontrolled observational studies.[49]

ii. Oropharyngeal and velopharyngeal surgery

There are various surgical techniques to address obstruction at velopharyngeal region.

A meta-analysis comparing barbed reposition pharyngoplasty (BRP) and expansion sphincter pharyngoplasty showed no significant difference between the two techniques in terms of AHI reduction in OSA. However, the quality of primary papers was poor.[52, level II-1]

In a meta-analysis evaluating the effects of lingual tonsillectomy with palatal surgery in OSA showed improvements postoperatively in:[53, level II-3]

- AHI (MD= -18.51/hour, 95% CI -31.72 to -5.31)
- minimal oxygen saturation (MD= 5.26, 95% CI 0.10 to 10.42)
- ESS (MD= -5.44, 95% CI -8.69 to -2.18)

In terms of complications, no postoperative airway compromise was reported. However, three of the patients in two included studies had significant bleeding which required revision surgeries. The quality of the included papers was moderate.

A recent systematic review showed good outcomes after BRP surgery. There was a significant difference between preoperative and post-operative values of AHI and ODI. The surgical success rate reported in the included studies ranged between 65.4% and 93%. There were no important intraoperative or postoperative complications in all studies. BRP has been proven to be safe and effective surgery in OSA.[54, level II-3]

Laser-assisted uvulopalatoplasty (LAUP) has been used as a surgical option to treat OSA. However, a meta-analysis showed that it only reduced AHI by 32% among all patients with only a minimal change in lowest oxygen saturation. A meta-analysis concluded that LAUP only gave a surgical success rate of 23% and cure rate of 8%, with worsening of the AHI among 44% of patients. The meta-analysis recommended that LAUP be performed with caution or not performed at all given the unfavourable results.[55, level I] However, quality assessment of the primary papers was not reported.

Temperature controlled radiofrequency tissue ablation (TCRFTA) can be applied at the level of the base of tongue, soft palate, or both levels depending on the predominant site of obstruction. A meta-analysis showed TCRFTA of the tongue base as a stand-alone procedure in OSA improved sleep parameters and symptoms at one-year post-treatment:[56, level I]

- RDI (respiratory disturbance index) (RoM=0.60, 95 % CI 0.47 to 0.76)
- LSAT (lowest oxygen saturation) (RoM=1.05, 95 % CI 1.01 to 1.10)
- ESS (RoM=0.59, 95 % CI 0.51 to 0.67)
- Snoring (RoM=0.48, 95 % CI 0.37 to 0.62)

TCRFTA of soft palate as stand-alone procedure showed no significant short-term improvements in RDI or ESS. However, there was significant improvement in snoring. On the other hand, TCRFTA of both levels showed significant reduction in RDI with symptom improvement (ESS and snoring) although the oxygenation parameters were not significantly improved at one-year post-treatment.

iii. Tongue surgery

Tongue surgery includes conventional glossectomy and transoral robotic base-of-tongue surgery.

A meta-analysis looked at the outcomes of glossectomy using three different techniques (midline glossectomy, lingualplasty and submucosal minimally invasive lingual excision) in patients with OSA. The analysis showed significant improvement in AHI, ESS, snoring visual analogue score and lowest oxygen saturation with glossectomy. It also revealed surgical success rate of 59.56% (95% CI, 52.99% to 65.96%) and cure rate of 22.5% (95% CI 11.26% to 36.26%) of OSA cases.[57, level III] However, no quality assessment was mentioned.

Transoral robotic base-of-tongue surgery (TORS BOT) is a newer alternative approach for tongue surgery in OSA. Two meta-analyses showed that TORS BOT led to a significant improvement in sleep-related outcomes (AHI, ESS and lowest oxygen saturation) in patients with OSA.[58, level II-3; 59, level III] The surgical success rate using this approach was 68.4% (95% CI 63.0 to 73.5) while the surgical cure rate was 23.8% (95% CI 19.1 to 29.2).[58, level II-3] Quality assessment in both meta-analyses were either not appropriate or not mentioned.

Currently, there is no retrievable evidence on direct comparison of effectiveness and cost-effectiveness between conventional glossectomy and transoral robotic base-of-tongue surgery.

Recommendation 6

- Upper airway surgery may be considered in selected group of obstructive sleep apnoea patients.
  - A follow-up polysomnography may be considered three months after surgery.

iv. Maxillary expansion in adults

Maxillary constriction in a transverse dimension has been shown to be one of the pathophysiological risks for OSA. This discrepancy leads to increased nasal airflow resistance and displacement of the posterior tongue leading to pharyngeal collapse.[6, level III]

Maxillary expansion in adults with OSA can be achieved by:

- surgical-assisted rapid palatal expansion (SARPE)
- distraction osteogenesis maxillary expansion (DOME)

These procedures:

- widen the nasal floor and increase palatal muscles tension to prevent palate collapsibility during sleep[60, level III]
- increase upper airway volume which improve nasal breathing and tongue space[61, level III]
- prevent posterior displacement of the tongue[61, level III]

A recent meta-analysis showed that SARPE in adults with OSA led to significant:[6, level III]

- reduction in nasal resistance

- improvement of self-reported questionnaire [Nasal Obstruction Symptom Evaluation (NOSE) score]

In another meta-analysis of adults with OSA, maxillary expansion also resulted in:[60, level III]

- decreased AHI from a mean of 24.3 events/hour (95% CI 15.3 to 33.3) to 9.9 events/hour (95% CI 5.4 to 14.4)
- improvement of lowest oxygen saturation from 84.3% (95% CI 81.7 to 87.0) to 86.9% (95% CI 85.1 to 88.7)

A cross-sectional study showed that DOME used to treat adult OSA patients with narrow maxilla and nasal floor led to significant:[62, level III]

- improvement in mean ESS score
- improvement in AHI
- reduction in NOSE score
- increased percentage of rapid eye movement (REM) sleep

- There is paucity of evidence on the amount of maxillary expansion needed to improve respiratory parameters and long-term improvements in OSA. However, the surgery can be considered in adults with moderate and severe OSA associated with a narrow maxilla and nasal floor.

d. Maxillomandibular Advancement

Maxillomandibular advancement (MMA) is one of the surgical interventions for patients with moderate to severe OSA. In a small RCT comparing MMA and CPAP in 50 patients with severe OSA, there was no significant difference in improvement of AHI and ESS.[63, level I] However, there was no explanation of randomisation or type of analysis done.

MMA with or without adjunctive surgical procedures had been shown to be an effective and predictable surgical treatment option for patients with moderate to severe OSA with a surgical success rate of 86% and cure rate ranging from 38 - 50%.[64 - 65, level II-3]

A recent meta-analysis of eight clinical trials on moderate to severe OSA showed that MMA:[66, level II-3]

- achieved surgical success with mean final AHI of 12.4/hour (95% CI 7.18 to 17.6)
- increased posterior airway volume (PAV) which correlated with improvements in postoperative AHI (r=0.75, 95% CI 0.65 to 0.85)

In another meta-analysis which examined the impact of MMA in OSA, it was shown that:[67, level II-3]

- upper airway volume increased in the vertical position (MD=8.909 mm^3, 95% CI 6.614 to 11.204) and supine position (MD=6.047 mm^3, 95% CI 5.539 to 6.565)

- AHI reduced (MD=45.596/hour, 95% CI 50.375 to 40.818)
- RDI reduced (MD=50.474/hour, 95% CI 63.680 to 37.089)
- oxygen saturation increased (MD=8.990%, 95% CI 5.205 to 12.775)
- ESS reduced (MD= -10.491, 95% CI -12.519 to -8.464)

There is no strong evidence to establish the magnitude and direction of maxillary or mandibular movement required to cure OSA and thus this should be tailored to each individual patient based on clinical assessment.

The stability of improvement in airway parameters with MMA has been reported to be sustained significantly over a mean follow-up of 10 months.[68, level II-3]

The revised Stanford Protocol (2019) state that the following patients can benefit from MMA:[69, level III]

- patients with OSA and concurrent dentofacial deformity
  - those who have a co-existing indication for orthognathic/ corrective jaw surgery are indicated for proceeding directly to MMA surgery to concurrently improve speech and mastication function
- patients with moderate to severe OSA without dentofacial deformity with:
  - complete lateral pharyngeal wall collapse on DISE
  - low hyoid position and obtuse cervicomental angle
  - high inclination of the occlusal plane

Potential complications of MMA have been reported to be low but can be divided into:[70, level III]

- intraoperative complications
  - bleeding due to injury to the descending palatine artery during maxillary downfracture
  - increased risk of unfavourable fracture patterns due to highly cortical bone
- early postoperative complications
  - airway obstruction which should be acutely recognised; moderate to severe OSA patients must be monitored in the ICU after extubation until the airway is confirmed to be secured
  - due to the large movements, there is increased risk of wound dehiscence and exposure of plate leading to possible infected plates requiring close postoperative monitoring
- late postoperative complications
  - malunion of bony segments
  - hardware issues relating to chronic sinusitis, acute infection or persistent pain
  - relapse of the OSA symptoms which require revision surgery

Recommendation 7
- Maxillomandibular advancement may be considered in certain patients with moderate to severe obstructive sleep apnoea.

e. Adjunctive Therapy

i. Mandibular advancement appliance

Mandibular advancement appliance (MAA) is a relatively non-invasive intra-oral device which is worn overnight to position the mandible in a forward and downward direction. In principle, by repositioning the mandible forward, the total airway volume during mandibular advancement increases, predominantly at the lateral dimensions, in the volume of the velopharynx, and to a lesser extent in the volume of the hypopharynx. The mechanics of airway volume increase is achieved through an increase in the lower anterior facial height, reduction in the distance between the hyoid and posterior nasal spine, lateral displacement of the parapharyngel fat pads away from the airway and anterior movement of the tongue base muscles. Consequently, this facilitates a reduction in AHI.[71, level III]

The effectiveness and safety of MAA vs other modalities were studied in adults with OSA in a meta-analysis and a network meta-analysis. CPAP was found to be more effective than MAA in reducing AHI with MD of between 8.243 (95% CI 3.354 to 13.132)[72, level I] and 9.59 (95% CrI 3.75 to 15.40).[73, level I]

Apart from that, the network meta-analysis of moderate quality papers also reported that CPAP was more effective than MAA in:[73, level I]
- Increasing lowest oxygen saturation (MD=5.25%, 95% CrI 7.64 to 3.22)
- reducing 24-hour SBP (MD=3.22 mmHg, 95% CrI 0.03 to 6.34) and daytime SBP (MD=4.58 mmHg, 95% CrI 0.71 to 7.98)

In another analysis, when compared with control (sham CPAP or placebo), MAA was more effective in:
- reducing AHI (MD=13.91/hour, 95% CrI 21.01 to 7.00)
- increasing lowest oxygen saturation (MD=3.71%, 95% CrI 1.39 to 6.42)
- reducing ESS (MD=1.58, 95% CrI 2.89 to 0.28)
- improving arousal index (MD=8.32/hour, 95% CrI 12.91 to 4.55)

MAA was an effective option in patients with poor compliance to CPAP. Compliance was significantly lower in CPAP than MAA by 1.1 hour per night. The quality of the primary papers in the meta-analysis was moderate.[72, level I]

The effectiveness of MAA is influenced by its design. Factors considered in MAA fabrication are mono-bloc vs dual-bloc, custom-made vs ready-

made and the amount of mandibular advancement. A meta-analysis comparing mono-bloc and dual-bloc MAA with success rate measured as:

$$\frac{\text{difference in mean AHI pre- and posttreatment}}{\text{mean AHI pretreatment}} \times 100\%$$

where the former had a higher success rate of 82.1% (95% CI 72.2 to 88.7) compared with the latter of 54.7% (95% CI 44.3 to 63.7). Mono-bloc MAAs also showed better improvement in the lowest oxygen saturation [10.048% (95% CI 7.733 to 12.363) vs 3.357% (95% CI 2.290 to 4.423)]. The primary papers included were of moderate quality.[74, level I]

Two systematic reviews found custom-made MAA to be more effective than ready-made MAA.[75 - 76, level I] Compared with ready-made MAA, custom-made MAA was more effective in:

- reducing AHI (MD= -3.52/hour, 95% CI -6.36 to -0.69)
- achieving better treatment response [defined as either partial (50% reduction in AHI) or complete (AHI <5/hour)], with an OR of 0.47 (95% CI 0.28 to 0.78)
- improving quality of life based on the Functional Outcomes of Sleep Questionnaire (MD=0.76, 95% CI 0.14 to 1.38).

Furthermore, patients preferred custom-made MAA ($p < 0.001$)[76, level I] and had better adherence with it (MD= -1.34, 95% CI -2.02 to -0.66).[75, level I]

A meta-regression analysis showed that the amount of mandibular advancement did not significantly influence the success rate of the MAA.[77, level I]

The usage of MAA had been associated with mild to moderate side effects including excessive salivation, temporomandibular joint (TMJ) discomfort, tooth discomfort, sore jaw muscles, dry mouth, occlusal change and difficulty chewing in the morning.[72, level I]
A meta-analysis found the skeletal changes after the use of MAA were rotation of the mandible (downward and forward), and increase in the SNA angle by 0.06 ± 0.03^{o}. While occlusal changes were:[78, level I]

- increase in the lower incisor proclination by 1.54 ± 0.16^{o}
- decrease overjet by 0.89 ± 0.04 mm
- decrease overbite by 0.68 ± 0.04 mm

Recommendation 8

- Mandibular advancement appliance may be considered for adult patients with obstructive sleep apnoea.
  - The preferred design should be tailored to the patient's condition.

ii. Myofunctional therapy

Myofunctional therapy refers to the combinations of oropharyngeal exercises. These combinations include both isotonic and isometric exercises which involve several muscles and areas of the mouth, pharynx and upper respiratory tract to work on certain functions e.g. speaking, breathing, blowing, sucking, chewing and swallowing. In a Cochrane systematic review, myofunctional therapy in OSA patients:[79, level I]

- reduced AHI (MD= -13.20 points, 95% CI -18.48 to -7.93) compared with sham therapy based on two studies of low-certainty evidence
- reduced AHI (MD= -6.20 points, 95% CI -11.94 to -0.46) compared with waiting list based on one study of low-certainty evidence
- increased AHI (MD= 9.60 points, 95% CI 2.46 to 16.74), compared with CPAP based on one study of low-certainty evidence
- increase AHI (MD=10.50 points, 95% CI 3.43 to 17.57), compared with CPAP based on one study of low-certainty evidence

iii. Pharmacotherapy

Pharmacotherapy has been used as an adjunct therapy in OSA patients with nasal obstruction and residual sleepiness.

Nasal obstruction is a common complaint in patients with OSA especially with concomitant allergic rhinitis. In a Cochrane systematic review, an RCT with moderate quality showed that intranasal fluticasone in OSA patients with allergic rhinitis significantly reduced AHI compared with placebo.[80, level I]

A more recent meta-analysis showed that intranasal corticosteroids improved AHI in OSA compared with placebo (SMD= -0.73, 95% CI, -1.23 to -0.23). The included studies reported only few mild AEs.[81, level I] However, the quality of the included studies was mixed.

In another meta-analysis on OSA, topical nasal treatments (oxymetazoline, xylometazoline and phenylephrine) did not significantly improve AHI compared with placebo. The included primary papers were of moderate quality.[82, level I]

Some OSA patients may have residual excessive daytime sleepiness even after using CPAP as first-line treatment. A meta-analysis showed that both modafinil and armodafinil improved subjective (based on ESS) and objective (sleep latency as measured by the Maintenance of Wakefulness Test) day time sleepiness in OSA compared with placebo as shown below:[83, level I]

Medication	ESS [WMD (95% CI)]	Maintenance of Wakefulness Test [WMD (95% CI)]
Modafinil	-2.96 (-3.73 to -2.19)	2.51 (1.50 to 3.52)
Armodafinil	-2.63 (-3.40 to -1.85)	2.71 (0.04 to 5.37)

With both medications, the most commonly reported AE was headache with RR of 1.78 (95% CI 1.20 to 2.65) in the modafinil group and 2.04 (95% CI 1.36 to 3.05) in the armodafinil group. Other AEs included were nausea, anxiety or nervousness, insomnia and dizziness. The quality of primary papers was moderate.[83, level I]

In the local setting, intranasal corticosteroids are prescribed to OSA patients with symptoms of allergic rhinitis and chronic rhinosinusitis.

Recommendation 9
- Intranasal corticosteroids may be prescribed to obstructive sleep apnoea patients with symptoms of allergic rhinitis and chronic rhinosinusitis.

f. Bariatric Surgery

AASM recommends that clinicians discuss referral for bariatric surgery in OSA patients with obesity (BMI ≥35 kg/m^2) who are intolerant or unaccepting of PAP. AASM made a strong recommendation in favour of bariatric surgery referral based on moderate-quality evidence from two RCTs and 28 observational studies.[49]

Recommendation 10
- In obese patients with obstructive sleep apnoea (BMI ≥35 kg/m^2), bariatric surgery may be considered.

3.4 General Principles of Perioperative Management of Suspected and Confirmed OSA

a. Preoperative Management of Suspected and Confirmed OSA

Patients with a high probability of OSA based on screening tools are at an increased risk of postoperative morbidity. Health care providers should consider making OSA screening as part of their standard pre-anaesthetic evaluation. An evidence-based guideline recommends:[84]
- patients with a diagnosis of OSA should be considered to be at increased risk for perioperative complications
- adult patients at risk for OSA should be identified before surgery
- screening tools e.g. STOP-BANG, perioperative sleep apnea prediction (P-SAP) score, Berlin questionnaire and American Society of Anesthesiologists (ASA) checklist can be used as

preoperative screening tools to identify patients with suspected OSA
- there is insufficient evidence to cancel or delay surgery to confirm OSA in patients high risk for OSA, unless there is evidence of uncontrolled systemic diseases

- Surgery should not be cancelled or delayed in patients with high risk of OSA preoperatively unless there is evidence of uncontrolled systemic disease.

Majority of OSA patients presenting for surgery are undiagnosed and lack sufficient time before surgery to undergo formal diagnostic PSG. There is inadequate evidence to recommend mandatory use of PSG in the preoperative period. A cross-sectional study showed that implementation of a universal screening initiative using STOP-BANG incorporated into the electronic medical record improved compliance of screening at 66.1% and thus identification of patients at high risk for OSA. Nearly 90% of patients in the high STOP-BANG score group (STOP-BANG Score of ≥4) were found to have a higher American Society of Anesthesiologists (ASA) physical status, higher co-morbidities and a mean BMI of 30.18 kg/m^2.[85, level III]

A prospective cohort study showed a positive correlation between STOP-BANG scores of 5 - 8 and AHI >15/hour (ρ=0.38, p<0.01). Patients with a STOP-BANG score of 5 - 8 had a higher risk of AHI >15/hour than those with a score of 3 - 4 (OR=2.9, 95% CI 1.1 to 7.8). There was no correlation between STOP-BANG of 3 - 4 and AHI >15/hour. Adding alternative scoring models with specific combinations of factors failed to improve the screening of the patients.[86, level III]

Recommendation 11
- Patients who are at risk of obstructive sleep apnoea (OSA) should be screened for OSA preoperatively.
  - The preferred screening tool is STOP-BANG.

b. Intraoperative Management of Suspected and Confirmed OSA

An evidence-based guidelines focusing on airway management looking at commonly used anaesthesia-related drugs and anaesthetic techniques in patients with OSA recommends:[87]
- known or suspected OSA should be considered an independent risk factor for difficult intubation, difficult mask ventilation or a combination of both; thus adequate difficult airway management precautions should be taken
- those who receive neuromuscular blocking agents may be at increased risk on effects of postoperative residual neuromuscular

blockade, hypoxaemia or respiratory failure; however, there is insufficient evidence to suggest the preference of any neuromuscular blocking reversal agent to reduce the risk of these complications
- patients may be at increased risk for adverse respiratory events from the use of opioid medication and propofol for procedural sedation; thus precaution should be practiced when these agents are used
- there is no specific recommendation on inhalational anaesthesia agents because of a lack of evidence in assessment of its residual effects
- patients may be at increased risk for adverse respiratory events from intravenous (IV) benzodiazepine sedation; thus it should be used with caution
- when applicable, regional anaesthesia is preferable over general anaesthesia

The difficult airway in OSA patients is a contributing factor to the high rate of adverse respiratory events and thus should be managed accordingly. A meta-analysis showed that there was 3-fold increase in difficult intubation (OR=3.46, 95% CI 2.32 to 5.16) and difficult mask ventilation (OR=3.39, 95% CI 2.74 to 4.18) in OSA patients compared with non-OSA patients. However, there were no significant difference in supraglottic airway failure rates between the groups.[88, level II-2]

In a narrative review, presence of OSA was associated with increased risk for major complications during and after surgery, including respiratory failure-intubation, prolonged mechanical ventilation, CV events, neurocognitive disorders, intensive care admission, prolonged hospital stay and readmission. These risk factors included excessive sedation, opioid-based analgesia, intubation and mechanical ventilation. Regional anaesthesia reduced incidence of major complications compared with general anesthesia in OSA.[89, level III]

Sleep apnoea is associated with negative outcomes following general anaesthesia. It has been a practice that short-acting anaesthetic agents are preferred to standard agents to reduce this risk. However, a small RCT showed that short-acting agents (desflurane-remifentanil) did not appear to reduce the impact of general anaesthesia compared with standard agents (sevoflurane-fentanyl) in terms of mean values of supine AHI on the first and third post perative nights. However, the prevalence of severe OSA on the third postoperative night was higher than on the preoperative night (OR=7.00, 95% CI 2.07 to 23.60). This data suggested that monitoring should be continued up to at least the third postoperative night.[90, level I] The RCT used per protocol analysis on certain outcomes.

One cross-sectional study analysed the effects of recovery time in patients with OSA receiving total intravenous anaesthesia (TIVA) and volatile gas anaesthesia for upper airway ambulatory otolaryngology surgery. TIVA significantly reduced the time spent in Post-anaesthesia Recovery Unit (PACU) across the severity of OSA. There was a strong correlation for patients on inhalational anaesthesia to have increased recovery times from PACU to the ward as OSA severity increased ($p<0.001$), whereas this was insignificant for those receiving TIVA.[91, level III]

Another cross-sectional study of bariatric patients undergoing pre-operative screening for oesophagogastroduodenoscopy compared the use of sealed nasal positive airway pressure mask and passive oxygenating devices. Those who used sealed nasal positive airway pressure mask significantly had higher BMI and ASA classification (**Appendix 7**), and were more likely to have OSA. They also had significantly lower incidence of desaturation events and higher median lowest O2 compared with those using passive oxygenating devices.[92, level III]

- Patients with OSA are at high risk of experiencing anaesthesia-related respiratory or CV complications.
- The following are important to be considered when anaesthesia is to be given to patients with OSA during the intraoperative period:
  - regional anaesthesia is preferred over general anaesthesia where it is applicable
  - TIVA is preferred over volatile anaesthesia
  - IV benzodiazepine should be used with caution during sedation
- Obstructive sleep apnoea is associated with difficult mask ventilation and intubation.

c. Postoperative Management of Suspected and Confirmed OSA

Higher postoperative adverse outcomes in the presence of OSA have been documented in patients undergoing various types of surgeries compared to the general population. The majority of OSA patients are undiagnosed and untreated during the perioperative period, adversely affecting post operative recovery. It has been recommended that assessment of patients for possible OSA before surgery is done with careful postoperative monitoring for those suspected to be at high risk of OSA.[84]

The patient and the treating health care team should be aware that a high probability of OSA may increase postoperative morbidity. The following have been recommended postoperatively in relation to adults with OSA.[84]

- Hospitals should have suitable PAP devices available for peri-operative use or ensure patients bring their own device to the hospital.
- Patients should wear their PAP device at appropriate times during their stay in the hospital, both preoperatively and post-operatively.
- Untreated OSA patients with optimised co-morbid conditions may proceed to surgery, provided strategies to minimise post-operative complications are implemented.

Patients with OSA are at risk of postoperative AEs because drugs used during general anesthesia may increase the risk of prolonged periods of apnoea.

- A meta-analysis showed that surgical patients with OSA were at increased risk of postoperative respiratory failure (OR=2.42, 95% CI 1.53 to 3.84) and cardiac events (OR=1.63, 95% CI 1.16 to 2.29) compared with non-OSA patients. Additionally, the presence of OSA was also associated with 2.5 times higher odds of unplanned transfer to an ICU following surgery (OR=2.46, 95% CI 1.29 to 4.68).[93, level I]
- Another meta-analysis showed that 85% of opioid-induced respiratory depression (ORID) occurred postoperatively within the first 24 hours. Surgical patients with pre-existing cardiac, respiratory disease or OSA were at increased risk for ORID. For example, patients with OSA had an OR of 1.4 (95% CI 1.2 to 1.7). Patients with post-operative OIRD received higher doses of morphine equivalent daily doses than controls (MD=2.8, 95% CI 0.4 to 5.3)[94, level II-2]
- A third meta-analysis among adult patients using STOP-BANG questionnaire showed that patients with high risk-OSA had 4-fold higher risk of post-operative complications compared with those with low risk-OSA (OR=3.93, 95% CrI 1.85 to 7.77). Additionally, their duration of hospital stay was longer (MD=2.01 days, 95% CrI 0.77 to 3.24).[95, level II-2]
- In a cross-sectional study, adverse respiratory events were a common occurrence in the PACU and were more frequently observed in high risk OSA (STOP-BANG >3) patients compared with low risk OSA (39% vs 10%, p<0.001). Patients with high risk OSA presented with mild-moderate hypoxemia and also high inability to breathe deeply (34% vs 9%, p=0.001). They also had a longer median stay in the PACU (120 min vs 99 min, p=0.035).[96, level III]

Recommendation 12
- Patients with or suspected high risk of obstructive sleep apnoea (OSA) should be monitored closely postoperatively.
- Hospitals should have suitable positive airway pressure devices available for perioperative use or ensure patients with OSA bring their own device to the hospital.

3.5 Monitoring and Follow-up

- Monitoring and follow-up of OSA cases are important in ensuring treatment response, adherence and optimisation of medical risk factors. AASM recommends periodic follow-up to confirm:[34]
  - adequacy of treatment via reduction of AHI
  - symptom resolution via objective questionnaire (e.g. sleepiness or QoL)
  - treatment adherence via PAP usage data
- OSA should be ideally managed by a multidisciplinary team consisting of respiratory physicians, otolaryngology surgeons, oral maxillofacial surgeons, orthodontists, bariatric surgeons and dietitians.

In addition to assessments of treatment effectiveness, AASM also recommends addressing issues associated with PAP therapy.[34] Examples are mask interface and humidification.

Following a surgical procedure and an appropriate period of healing (weeks to months), patients should be assessed using PSG or HSAT. The patients should be assessed clinically on periodic basis since OSA may recur post-operatively.[97]

AASM recommends follow-up PSG or HSAT can be considered:[97]
- after a 10 - 20% reduction or increase in weight
- after at least three months of recovery following weight loss surgery

3.6 Referral

a. Referral for Sleep Medicine Services

Sleep medicine services in Malaysia for the management of OSA are offered by multidisciplinary specialties including respiratory medicine, otorhinolaryngology (ORL), oral and maxillofacial surgery, and orthodontic.

CPG DG opines that all patients with clinical suspicion of OSA with or without cardio-metabolic risk factors and STOP-BANG score ≥3 should be referred for diagnostic sleep test.

Recommendation 13

- Patients with clinical suspicion of obstructive sleep apnoea with or without cardio-metabolic risk factors and STOP-BANG score ≥3 should be referred for diagnostic sleep test.

b. Referral Criteria for Surgical Intervention

CPAP is the mainstay of OSA treatment but its effectiveness can be compromised when the patients are unable to adhere to it. Consultation with the physician should be made to address barriers to adherence. Surgeries can improve adherence of CPAP or complement other therapies.

Surgical referral for alternative treatment options has been recommended for adult OSA patients with:[49]

- BMI <40 kg/m^2 who are intolerant or unaccepting of PAP
  obesity (BMI ≥35 kg/m^2) who are intolerant or unaccepting of PAP for bariatric surgery
- BMI <40 kg/m^2 and persistent inadequate PAP adherence due to pressure-related side effects
- major upper airway anatomic abnormality (PAP should be offered as initial therapy before considering upper airway surgery)

4 OBSTRUCTIVE SLEEP APNOEA IN CHILDREN

4.1 Epidemiology and Risk Factors

The prevalence of OSA in children is 1 - 4%.[98, level III]

OSA in children is defined by the presence of sleep disordered breathing symptoms in combination with AHI >1 events/hour.[99] Clinical presentation of OSA in this group varies from symptoms directly related to upper airway obstruction to the complications related to OSA itself (refer to **Table 3**).

Table 3. Clinical presentation of OSA in children

Symptoms of upper airway obstruction	Complications of OSA
Snoring Witnessed apnoea Difficulty in breathing Abnormal sleep posture Mouth breathing Excessive sweating	Elevated blood pressure Enuresis Excessive daytime sleepiness Inattention/hyperactivity Cognitive deficits Academic difficulties Failure to thrive Morning headache

Adapted: Joosten KF, Larramona H, Miano S, et al. How do we recognize the child with OSAS?. Pediatr Pulmonol. 2017;52(2):260-271.

Patient with these risks or abnormalities are encouraged to be screened for OSA:[100, level III]

- obesity
- prematurity
- adenotonsillar hypertrophy and family history of adenotonsillar hypertrophy
- nasal septum deviation, allergic rhinitis
- craniofacial anomalies
- maxillary (midface) hypoplasia in craniosynostosis syndromes
- mandibular hypoplasia without or with cleft palate
- neuromuscular disorder
- complex disorders: achondroplasia, Chiari malformation, Down syndrome, Ehlers–Danlos syndrome, mucopolysaccharidoses, Prader–Willi syndrome

In a cross-sectional study involving infants 0 - 17 months of age with a diagnosis of OSA by clinical features and nocturnal PSG, additional co-morbidities of OSA found were gastroesophageal reflux, periodic limb movements in sleep, laryngomalacia/tracheomalacia and epilepsy.[101, level III]

Snoring history is often missed by parents and caregivers of children and adolescents with OSA due to adenotonsillar hypertrophy and obesity. Although it is easy to elicit, it is not specific to OSA.[2]

- Snoring is common among children and adolescents with adenotonsillar hypertrophy and obesity. History of snoring should be obtained to suspect OSA in this group.

4.2 Diagnosis

Recognising and diagnosing OSA in children requires a high index of clinical suspicion. A meta-analysis of 10 diagnostic studies on clinical assessment of OSA in children showed substantial variation in the sensitivity and specificity among different symptoms and signs i.e. snoring, observed apnoea, difficulty in breathing, excessive daytime somnolence and tonsillar size. Several models using combinations of symptoms and signs had been proposed but showed mixed results in diagnostic accuracy. One of the models that has been studied was Paediatric Sleep Questionnaire (PSQ) by Chervin RD et al. 2000 which had a sensitivity of 0.78 and specificity of 0.72.[102, level III] PSQ score of ≥8 indicate sleep related breathing disorder. In a recent meta-analysis using PSG as the reference standard, PSQ had good sensitivity in screening for all severity of OSA in children [sensitivity of 73% (95% CI 67 to 78), 80% (95% CI 71 to 86) and 89% (95% 75 to 97) for mild, moderate and severe respectively].[103, level III] The questionnaire had been validated in several languages. In a local study, both English (**Appendix 10**) and Malay PSQ (**Appendix 11**) had acceptable psychometric measurement properties (Cronbach's α of 0.753 and 0.760 respectively) to assess SDB in the Malay speaking population.[104, level III]

The gold standard diagnostic test for OSA in children is overnight, attended, in-laboratory PSG (PSG level 1). The PSG will demonstrate the severity of OSA which helps in short- and long-term management of the patients. Specific measuring and scoring criteria for children should be used in the interpretation of the PSG results. If level I PSG is not available, clinicians may opt for alternative diagnostic tests e.g. nocturnal video recording, overnight pulse oximetry, daytime nap PSG or ambulatory PSG.[2]

- OSA in children is diagnosed in the presence of symptoms with:[105, level III]
  - AHI ≥2 or obstructive apnoea index ≥1
    OR
  - AHI ≥1 (including central events)

Severity of OSA in children are shown as below:

AHI	Severity of OSA
<5/hr	No OSA
5-15/hr	Mild
15-30/hr	Moderate
>30/hr	Severe

Reference: Kaditis A, Kheirandish-Gozal L, Gozal D. Pediatric OSAS: Oximetry can provide answers when polysomnography is not available. Sleep Med Rev. 2016;27:96-105.

In Malaysia, diagnostic testing of OSA in children is more challenging compared to adult including limited facilities for PSG for children. A systematic review studied diagnostic test accuracy (DTA) of different tests for OSA in reference to PSG in children. Sleep lab-based polygraphy, urinary biomarkers, and rhinomanometry showed excellent DTA. However, the quality of the primary studies was generally low.[106, level III]

A meta-analysis showed good overall diagnostic accuracy of type 3 PSG compared with full PSG in predicting OSA in children with sensitivity of 76% (95% CI 64 to 85%), specificity 76% (95% CI 60% to 88%) and AUC of 0.88. However, the methodological quality of the primary papers was poor.[107, level III]

Overnight pulse oximetry is readily available in the local healthcare system. A systematic review on overnight pulse oximetry as a testing modality for the diagnosis of OSA in children showed that at least three clusters of desaturation events and at least three oxygen saturation (SpO_2) drop below 90% in a overnight pulse oximetry recording were indicative of moderate-to-severe OSA. An ODI_4 >2 episodes/hour combined with OSA symptoms also exhibited high PPV (84%) for AHI >1/hour. Apart from that, McGill Oxymetry Score has shown good sensitivity and specificity for OSA. The included studies had moderate to high risk of bias.[105, level III] Pulse oximetry had good sensitivity in screening moderate and severe paediatric OSA as shown in a recent meta-analysis [sensitivity of 0.83 (95% CI 0.69 to 0.91) and 0.83 (95% CI 0.57 to 0.94) respectively]. It also had a good specificity in mild, moderate and severe OSA in children (specificity ranged from 0.75 to 0.86).[103, level III]

An overnight pulse oximetry must have the following technical requirements:[108, level III]

- sufficient recording capacity for overnight monitoring
- short averaging time (<3 seconds at a heart rate of 80 bpm)

Recommendation 14
- Paediatric Sleep Questionnaire (PSQ) should be used as a screening tool for obstructive sleep apnoea (OSA) in children.
- Polysomnography level 1 should be considered for diagnosis of OSA in this group especially those at risk.
  - If it is not available, overnight pulse oximetry may be used as an alternative diagnostic tool.

4.3 Airway Assessment

Flexible fiberoptic nasopharyngoscopy is often used to identify potential sites of airway obstruction in children e.g. enlarged nasal turbinates, septal deviation, adenoid hypertrophy, lingual tonsil hypertrophy, tongue base prolapses and laryngomalacia. The evaluation may be limited by several factors. Namely, children may not cooperate and also the examination is performed in an upright position on awake patients, it may not capture the dynamic upper airway collapse that may occur exclusively during sleep.[109, level III]

DISE, on the other hand, is commonly performed in children who have undergone previous or prior to AT. Typically, this is done in children who are at high-risk for persistent OSA including those with obesity, severe OSA, Down syndrome, craniofacial anomalies (i.e., Pierre Robin sequence, Treacher Collins syndrome), hypotonia and neurologic impairment. DISE has been used to decide on definitive management of OSA.[109, level III]

- DISE allows the surgeon to address multiple levels of airway obstruction and decide on definitive management of OSA in children.
- Craniofacial assessment should be done to rule out the effect of the skeletal pattern on the airway dimension (refer to Subchapter 5.2) as a contributory factor to OSA.

4.4 Treatment

a. Pharmacotherapy

A Cochrane systematic review on the effectiveness and safety of anti-inflammatory drugs for OSA treatment in children showed no difference between intranasal corticosteroids and placebo on improvement of AHI. However, montelukast group had lower AHI compared with placebo (MD= -3.41, 95% CI -5.36 to -1.45). AEs of these medications were rare and minor e.g. nasal bleeding.[110, level I] The four RCTs included in the review were of moderate quality.

In a recent meta-analysis of four moderate quality RCTs in children with OSA, the following comparisons using oral montelukast showed:[111, level I]

- oral montelukast vs placebo
  oral montelukast improved OAHI (SMD= -0.99/hour, 95% CI -1.40 to -0.58), ODI (MD=-2.83/hour, 95% CI -3.86 to -1.79), AI (SMD= -1.02/hour, 95% CI -1.47 to -0.57) and minimal SpO_2 (MD=4.07%, 95% CI (2.27 to 5.88).
- oral montelukast + routine drugs vs routine drugs (i.e. antitussive, expectorant, antihistamines and antibiotics)
  combination of oral montelukast with routine drugs improved AHI (MD= -1.62/hour, 95% CI -2.63 to -0.61) and minimal SpO_2 (MD=2.53%, 95% CI 0.88 to 4.18)
- oral montelukast + nasal spray of mometasone furoate vs nasal spray of mometasone furoate combination of oral montelukast with nasal spray of mometasone furoate improved AHI (MD=0.46/hour, 95% CI 0.04 to 0.88) and minimal SpO_2 (MD=2.30%, 95% CI 1.58 to 3.02)

In terms of safety, AEs reported were headache, nausea and vomiting in the oral montelukast group.

Recommendation 15
- Oral montelukast and/or nasal corticosteroids may be considered in children with obstructive sleep apnoea.

b. Surgery

Adenotonsillectomy (AT) is the most commonly performed procedure in children with adenotonsillar hypertrophy and OSA. In a systematic review, children with AT had 75% surgical success.[112, level I] In a large RCT in children with OSA aged 5 - 9 years old, normalisation of PSG findings was observed in 79% of children in the early-AT group compared with 46% in those of watchful-waiting group ($p<0.001$).[113, level I]

In children post-AT, persistent OSA symptoms may be due to multilevel obstruction, which is particularly found in children with co-morbidities e.g. Down syndrome, obesity and craniofacial abnormalities.[112, level I] Adjunct surgical treatments e.g. lingual tonsillectomy, supraglottoplasty, epiglottopexy and tracheostomy can be offered to them. Before considering further surgical management, the anatomic location of obstruction needs to be determined. This can be undertaken in several ways e.g. flexible awake laryngoscopy and DISE.[114, level III]

The adenoids may regrow after incomplete adenoidectomy due to various factors.
- smaller nasopharynx in young children
- method of adenoidectomy - curettage adenoidectomy leaves residual adenoid tissue
- infection leading to inflammation of the residual tissue

Hence, revision adenoidectomy is needed and surgical method with direct visualization should be used.

Tonsillar tissue may regrow in the cases when there is residual tissue after surgery or in some cases when tonsillotomy was performed.

Recommendation 16

- Adenotonsillectomy (AT) is the treatment of choice in children with obstructive sleep apnoea due to adenotonsillar hypertrophy.
  - In those with post-AT residual disease, upper airway and multilevel obstruction should be reassessed and managed accordingly.

c. Continuous positive airway pressure

Continuous positive airway pressure (CPAP) is one of the therapies in children with OSA. It delivers positive pressure via a nasal mask to mechanically stent the airway and improve functional residual capacity.

CPAP management is challenging in children and only a small percentage tolerate therapy. In a systematic review, caregiver support was shown to increase adherence to CPAP [longer CPAP use/night by 86.60 minutes (95% CI 10.90 to 162.30) and percentage of CPAP usage more than 4 hours/ night by 18.10% (95% CI 3.87 to 32.33)] compared with absence of caregiver support. Mode of PAP delivery (BiPAP, CPAP and APAP) did not significantly improve adherence.[115, level I]

CPAP therapy is indicated in children with OSA if they have persistent symptoms or signs after surgery or in whom surgery is contraindicated. Some of the relative contraindications for adenotonsillectomy include:[2]

- morbid obesity and small tonsils/adenoid
- bleeding disorder refractory to treatment
- submucus cleft palate

It is also recommended that children on CPAP should be managed by a clinician with expertise in this field. CPAP pressure must be titrated in the sleep laboratory before therapy is being prescribed. During follow-up, objective monitoring of adherence, presence of side effects and any factors causing suboptimal therapy must be assessed and CPAP pressure titrated accordingly. Behavioural modification therapy may be required to improve adherence especially in young children or those with developmental delay. Children grow rapidly and therefore the mask fit must be assessed at least six-monthly.[2] Complication related to mask (e.g. midfacial hypoplasia) can be minimised by close monitoring and pro-active approach.[116]

There is no recent evidence on advantage of using BiPAP over CPAP. A cross-sectional study showed no difference in adherence between automated continuous positive pressure (APAP) and CPAP in paediatric group with OSA.[117, level III]

Recommendation 17

- Continuous positive airway pressure (CPAP) should be offered to children with obstructive sleep apnoea if they have persistent symptoms or signs after surgery or in whom surgery is contraindicated.
  - Nasal CPAP is the preferred option
  - CPAP should be managed by experienced and skilled multidisciplinary clinicians

d. Adjunctive therapy

i. Orthodontic functional appliances

Functional appliance is a type of mandibular advancement appliance used for orthodontic correction in growing adolescents (10 - 16 years old) for the treatment of mandibular retrognathia.

A systematic review on children and adolescents (<16 years old) with mild to moderate OSA who require orthodontic correction for their malocclusion (e.g. mandibular retrognathia, deep bite and crossbite) showed limited evidence to suggest that functional appliance result in short-term (6 - 12 months) improvement in AHI scores. The AHI reductions were significant with:[118, level I]

- full time wear of the twin block functional appliances
- part time wear of modified monoblocs
- full time wear of a customised mandibular repositioning oral appliance

However, the quality of the primary papers was low.

In a Cochrane systematic review oral or functional appliances showed better reduction in AHI with RR of 0.39 (95% CI 0.20 to 0.76) compared with no treatment in children with OSA. The oral appliance also reduced daytime and nocturnal symptoms of:[119, level I]

- oral breathing (RR=0.16, 95% CI 0.04 to 0.59)
- nasal stuffiness (RR=0.18, 95% CI 0.05 to 0.69)
- habitual snoring (RR=0.18, 95% CI 0.06 to 0.55)
- restless sleep (RR=0.21, 95% CI 0.05 to 0.84)

However, the quality of primary papers was low.

ii. Maxillary expansion

Maxillary expansion devices are used to correct transverse skeletal discrepancy e.g. narrow maxilla and posterior crossbites in growing children.

A network meta-analysis did not find rapid maxillary expansion (RME) to effectively reduce the AHI compared with controls and other types of treatment. In terms of effectiveness in AHI reduction, AT + pharyngoplasty was the most effective in reducing AHI (WMD=9.81/hour, 95% CI 2.18 to 17.44) when compared with no treatment. RME was found to be one of the most effective interventions to improve lowest oxygen saturation compared with AT.[120, level I] However, quality of included primary papers were not mentioned.

In a systematic review comparing pre-and post-treatment, RME was found to improve the AHI (MD= -4.84/hour, 95% CI -8.47 to -1.21) and lowest oxygen saturation (MD=5.78, 95% CI 1.99 to 9.58).[121, level I]

iii. Maxillary skeletal protraction

Maxillary protraction is used for correction of maxillary retrognathia in growing children. Currently, there is no evidence on maxillary protraction for the treatment of OSA in children.

- More strong evidence is warranted before orthodontic appliances e.g. functional appliances, RME and maxillary protraction devices can be recommended for the treatment of OSA in children. However, if an OSA patient presents with skeletal discrepancies, they can be considered for orthodontic appliances.

4.5 Perioperative Management in Paediatric

An increase in prevalence of paediatric OSA and obesity, surgical procedures poses a practical challenge to the anaesthesiologist. In general, the principles of perioperative anaesthetic management of a paediatric group at high risk or with OSA for surgical procedures are as outlined below.[98, level III]

a. Preoperative assessment

- Detailed medical history which includes screening questionnaire, review of medical record, clinical risk factors and co-morbidity and targeted physical examination are mandatory.
- Severity of OSA, lowest and duration of oxygen desaturation and CO^2 measurement from the PSG results if available should be documented.
- Patients with lowest oxygen desaturation <70% must be referred for further cardiopulmonary assessment.
- Sedative premedication should be administered with caution and those receiving it should be monitored with continuous pulse oximetry.

b. Intraoperative management

- There is no current evidence or consensus to support any specific anaesthesia technique.
- In cases of potential difficult intubation, appropriate airway adjunct i.e. fibreoptic bronchoscope, video laryngoscope and difficult airway cart should be made available.
- Anaesthesia with opioid sparing technique is preferred.
- Awake extubation is advocated.

c. Postoperative care

- Continuous monitoring is strongly recommended in OSA patients. It can be done in the general or critical care wards.

- The CPG DG opines that moderate to severe OSA patients with the following conditions may require monitoring in critical care wards:
  - patient factor - neuromuscular disorder, craniofacial anomalies, requirement of oxygen preoperatively
  - surgical factor - surgery near or above diaphragm
  - anaesthetic factor - postoperative IV narcotic or patient-controlled analgesia

- Postoperative use of BiPAP and CPAP at the preoperative setting may be continued.
- Postoperative analgesia choices include non-steroidal anti-inflammatory drug and paracetamol.

In a practice guideline for the perioperative management of patients with OSA, the American Society of Anesthesiologists Task Force recommends to consider the use of local peripheral nerve blocks and central neuroaxial anaesthesia when indicated. Patients who are at an increased perioperative risk from OSA should not be discharged to an unmonitored setting following recovery from anaesthesia until they are no longer at risk of post operative respiratory complications.[122]

Dexmedetomidine is associated with an overall perioperative opioid-sparing effect in paediatric patients undergoing AT with a significant reduction in perioperative opioid use.[123, level III]

Recommendation 18

- Perioperative assessment should be thoroughly performed in the paediatric group at high risk and those diagnosed with obstructive sleep apnoea (OSA).
- Paediatric patients at an increased perioperative risk from OSA should be closely monitored following recovery from anaesthesia.

4.6 Monitoring and Follow-up

All paediatric OSA should be monitored and followed-up between six weeks to 12 months after each treatment intervention. The parameters to be assessed during follow-up include symptoms, severity of OSA evaluated objectively, complications from the cardiovascular and central nervous system, quality of life, enuresis and paediatric growth rate. PSG is the preferred objective method to detect residual OSA after a treatment intervention. However, in settings where PSG is not available, alternative methods e.g. polygraphy, oximetry and capnography can be considered for use.[99]

AASM guidelines recommend that all OSA patients with persistent signs and symptoms after therapy should be reassessed to determine whether further treatment is required.[124, level III]

ERS Task Force further describes the criteria and interval of reassessment of children with OSA:[99]

- persistent SDB symptoms or at risk of persistent OSA pre-operatively ≥6 weeks after AT
- mild OSA treated with montelukast/nasal corticosteroids after 12 weeks of treatment
- post-RME at 12 months or earlier if symptoms persist

The ERS Task Force also recommends repeat titration of PAP therapy at least annually or earlier if there is a clinical indication.[99]

On follow-up, adherence to PAP therapy is measured objectively within three months of treatment initiation. If the therapy is ineffective, measures to improve adherence e.g. behavioural modification, treatment of CPAP side effects or alternative treatments can be instituted.[124, level III]

Children with OSA especially the high-risk group must be under follow-up by a multidisciplinary team consisting of paediatrician or respiratory paediatrician, ORL, craniofacial surgeon, intensivist, orthodontist and other relevant specialists trained in sleep medicine.[125]

Children with OSA who require long-term use of CPAP must be monitored by paediatric respiratory specialist with paediatric sleep experience objectively by follow-up PSG to determine CPAP requirement.[2]

During follow-up, monitoring of CPAP therapy complications e.g. nasal bridge pressure sores, oronasal dryness, eye irritation discomfort and flattening of the midface (from long-term use of the interface on growing facial structures) may occur and require early recognition for intervention by attending clinicians.[126]

Recommendation 19

- Children with obstructive sleep apnoea (OSA) especially the high-risk group should be followed-up by multidisciplinary team trained in sleep medicine.
- Children with OSA who require long-term use of continuous positive airway pressure (CPAP) should be monitored objectively by respiratory paediatrician with paediatric sleep experience.
- Monitoring of CPAP therapy complications is required during follow-up.

5. SPECIAL GROUP

5.1 Pregnancy

OSA is common in pregnancy and associated with various pregnancy-related health outcomes. A meta-analysis showed that the worldwide prevalence of OSA among pregnant women was 15% (95% CI 12 to 18). The estimated prevalence for each trimester ranged from 15 - 19%. OSA was linked to a higher risk of pregnancy induced hypertension, pre-eclampsia, gestational diabetes, pulmonary oedema during pregnancy, Caesarean-section and postoperative wound complications. The OR values were 1.97, 2.35, 1.55, 6.35, 1.42, and 1.87 respectively. OSA was also related to an increased risk for preterm birth (OR=1.62) and neonatal intensive care unit admission (OR=1.28).[127, level II-2]

a. Screening and Diagnosis

Pregnant woman with risk factors especially obesity and craniofacial anomalies should be asked about symptoms of OSA. The use of screening questionnaires may not be helpful based on the following evidence.

A meta-analysis showed that performance of screening questionnaires for OSA during pregnancy were poor to fair.[128, level III]

- BQ had pooled sensitivity of 0.66 (95% CI 0.45 to 0.83) and specificity of 0.62 (95% CI 0.48 to 0.75)
- ESS had pooled sensitivity of 0.44 (95% CI 0.33 to 0.56) and specificity of 0.62 (95% CI 0.48 to 0.75)

In one of the included studies, a large cross-sectional study on pregnant women in their third trimester showed the overall predictive ability of the screening tools (STOP, STOP-BANG, BQ, ASA Checklist and ESS) for OSA was modest with AUC of 0.62 to 0.695. However, none of the screening tools accurately identified OSA among the patients.

Diagnosing OSA in a pregnant woman is a challenge for physicians. The gold standard for objective testing is level 1 PSG which is time-consuming, labour-intensive and costly. Unattended, portable home PSG is a reasonable alternative among the general population. However, the American Academy of Sleep Medicine (AASM) guideline for the use of portable home polysomnography excludes pregnant women.

b. Treatment

There is lack of evidence on the treatment of OSA in pregnancy. In a small RCT on pregnant women with gestational diabetes, two weeks of CPAP treatment resulted in significantly lower rates of preterm delivery, unplanned cesarean section and neonatal intensive care unit admissions compared with no CPAP. However, there was no OSA parameters measured in the study.[129, level I]

A cohort study of pregnant women with hypertensive disorder showed that CPAP significantly reduced the incidence of severe forms of hypertensive syndrome and improved both lowest oxygen saturation and ESS after one month of CPAP usage. The respiratory event index was significantly associated with hypertension severity.[130, level II-2]

Recommendation 20
- Pregnant woman with suspected obstructive sleep apnoea based on symptoms and signs should be referred for further management by a multidisciplinary specialist team.

5.2 Craniofacial Anomalies

a. Risk of OSA

Children with craniofacial anomalies (CA), e.g. Pierre Robin Sequence (PRS) with micrognathia, retrognathia, glossoptosis with or without cleft lip/palate, have an increased risk of OSA due to upper airway obstruction as the tongue is relatively large compared to the mandibular structures and tends to prolapse backwards. Airway obstruction in these groups can be severe and results in intermittent hypoxia that may impair long-term cognitive and intellectual development.[131, level III]

Children with midface and mandibular hypoplasia have variable severity of OSA which correlates with the degree of hypoplasia. Almost 30% of paediatric group with syndromic cleft lip or palate are screened positive for OSA. The risk of OSA increases due to changes in the upper airway structure which include nasal deformities. OSA is more severe in PRS patients with cleft palate than those with isolated cleft palate.[132 - 136, level III]

Children below 18 years old with Class II skeletal pattern, tendency for backward growth rotator[137, level I] and reduced upper airway sagittal width are at risk of OSA.[138, level II-2]

A meta-analysis on the craniofacial morphological characteristics (refer to Figure 1): associated with OSA in non-syndromic paediatric patients compared with controls showed.[137, level I]

- the cephalometric findings i.e. angle between sella, nasion and B point (SNB) and difference between SNA and SNB, where SNA is the angle between sella, nasion and A point, while SNB is the angle between sella, nasion and B point (ANB) angles, indicated more Class II skeletal pattern:
  - SNB (MD= -1.79^{o}, 95% CI -2.61 to -0.97)
  - ANB (MD = 1.38^{o}, 95% CI 0.83 to 1.92)
- the cephalometric finding i.e. angle between mandibular plane and sella nasion line (MP-SN) angle, indicated more vertical growth (MD=4.20^{o}, 95% CI 3.32^{o} to 5.07^{o})

In a separate meta-analysis to elucidate the association between craniofacial disharmony and paediatric sleep-disordered breathing compared with controls showed:[138, level II-2]

- the cephalometric finding i.e. ANB angle, indicated a more Class II skeletal pattern (MD=1.64, 95% CI 0.88 to 2.41)
- reduced distances in the distance from the posterior nasal spine to the nearest adenoid tissue measured along the PNS-basion line (PNS-AD1) and distance from the posterior nasal spine to the nearest adenoid tissue measured along the line perpendicular to the sella-basion line (PNS-AD2), indicating reduced upper airway sagittal width in children with OSAS
  - PNS-AD1 (MD= -4.17, 95% CI -5.85 to -2.50)
  - PNS-AD2 (MD=3.12, 95% CI-4.56 to -1.67)

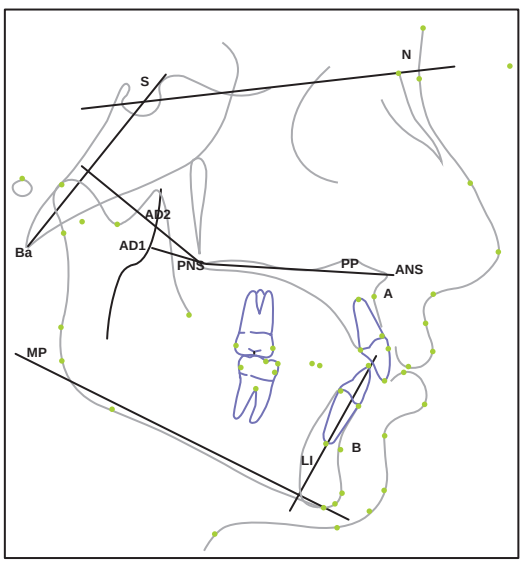


Figure 1. Cephalometric references and landmarks used in the meta-analysis: S, Sella; N, nasion; Ba, basion; ANS, anterior nasal spine; PNS, posterior nasal spine; PP, palatal plane; A, A-point; B, B-point; MP, mandibular plane (gonion-menton); PNS-AD1, distance from PNS to the nearest adenoid tissue measured along the line PNS-Ba; PNS-AD2, distance from PNS to the nearest adenoid tissue measured along the line perpendicular to S-Ba; LI long axis of the mandibular incisor.

Abbreviation list:

- MP-SN: angle between mandibular plane and sella nasion line
- SNB: angle between sella, nasion and B point

- ANB: difference between SNA and SNB, where SNA is the angle between sella, nasion and A point, while SNB is the angle between sella, nasion and B point
- PNS-AD1 (distance from the posterior nasal spine to the nearest adenoid tissue measured along the PNS-basion line)
- PNS-AD2 (distance from the posterior nasal spine to the nearest adenoid tissue measured along the line perpendicular to the sella-basion line)

Adapted: Katyal V, Pamula Y, Martin AJ, et al. Craniofacial and upper airway morphology in pediatric sleep-disordered breathing: Systematic review and meta-analysis. Am J Orthod Dentofacial Orthop. 2013;143(1):20-30.e3.

b. Treatment

The principle of treatment of OSA in CA is to secure a safe airway in the children especially infants. In neonates or infants with severe airway obstruction, a tracheostomy tube to bypass the obstructed upper airway is necessary until corrective surgery can be performed.[139 - 140, level III]

Surgical treatment of OSA in CA children include mandibular distraction osteogenesis, AT and rapid maxillary expansion. Evidence have shown that OSA has improved in these children after these surgeries.[133, level III; 140 - 142, level III]

Recommendation 21

- Patients with obstructive sleep apnoea and craniofacial anomalies should be assessed for the benefit and risk of a surgical intervention.

Non-surgical treatment using nasal CPAP and oxygen therapy may be useful if surgery is not possible or in mild to moderate OSA. Medications like proton pump inhibitor may also be used.[141; level III; 143 - 144 level III]

5.3 Down Syndrome

Patients with Down syndromes (DS) are known to be at high risk for OSA. The prevalence of OSA in DS varies from 45% to 82%. There are multiple factors to explain the increased prevalence of OSA in DS which include differences in anatomy and physiology. Soft tissue crowding of the pharynx and palate caused by midfacial and mandibular hypoplasia is further exacerbated by an increased incidence of adenotonsillar hypertrophy, relative macroglossia and glossoptosis, laryngomalacia, and subglottic and tracheal stenosis. Due to its high prevalence, screening and treatment for this group of patients are strongly supported.[145, level III]

A recent study showed no association between age and the severity of OSA in DS. However, more infants and children age <2 years had more severe disease than those aged ≥2 years (p=0.005). Of those with ongoing monitoring, 78.0% had moderate or severe OSA at some time.[146, level III]

Treatment of OSA in DS includes pharmacotherapy, CPAP and surgery. AT is one of the mainstay treatments of OSA in this group. Significant improvements in obstructive AHI, and minimum oxygen saturation was obtained in DS patients treated with AT. However, almost half of them had persistent OSA post operatively.[147, level III]

Recommendation 22

- Patients with Down syndrome should be screened for obstructive sleep apnoea and treated accordingly.

The summary of management for children with OSA is based on the level of obstruction as shown in **Appendix 12**.

5.4 Obesity Hypoventilation Syndrome

Obesity hypoventilation syndrome (OHS) is defined as a combination of:[148; 149]

- obesity (BMI ≥30 kg/m^2)
- daytime hypercapnia [arterial carbon dioxide tension ($PaCO_2$) ≥45 mmHg]
- sleep disordered breathing
- exclusion of alternative causes of alveolar hypoventilation

OHS is typically diagnosed during an episode of acute-on-chronic hypercapnic respiratory failure. Approximately 90% of patients with OHS have OSA.

A systematic review comparing noninvasive ventilation (NIV) vs CPAP as initial treatment of OHS with severe OSA showed that:[150, level I]

- no death reported within three months and no significant difference of death at 5.5 years follow-up (based on low certainty evidence)
- no significant difference in the resolution of hypercapnia up to three months (based on moderate certainty evidence) or three years of treatment (based on low certainty evidence)
- PaO2 improved with both modalities, with no significant difference between them up to three months and after three years follow-up (based on high certainty evidence)
- no significant difference in proportion of patients who did not require supplemental oxygen after three months and three years (based on moderate certainty of evidence)
- no significant difference in sleep parameters i.e. change in AHI at two months (based on moderate certainty evidence) and

excessive daytime sleepiness at three months and three years (based on low to moderate certainty of evidence)

CPAP was conditionally recommended over NIV as the first-line treatment for stable ambulatory patients with OHS and co-existent severe OSA because it had similar effectiveness but less costly and required less resources.[150, level I]

Recommendation 23

- Continuous positive airway pressure is the preferred initial treatment in stable ambulatory patients with obesity hypoventilation syndrome and severe obstructive sleep apnoea.

6. IMPLEMENTING THE GUIDELINES

Management of OSA should be guided by the latest evidence and availability of local resources to provide quality care to patients. Several factors may affect the implementation of recommendations in the CPG. OSA is best managed by a multidisciplinary approach to ensure success of treatment and reduction of complications.

6.1 Facilitating and Limiting Factors

Existing facilitators for application of the recommendations in this CPG include:

- availability of CPG to health care providers (hard copies and soft copies/online)
- regular seminars/conferences/courses for health care providers on management of OSA including those involving professional bodies (e.g. Sleep Disorder Society Malaysia, Malaysian Thoracic Society, Malaysia Society of Oral, Head and Neck Surgery and Family Medicine Specialist Association)
- public awareness activities during World Sleep Day including the involvement of governmental/non-governmental organisations e.g. Gabungan Persatuan Pemandu Pengangkutan Darat Malaysia, Malaysian Pilots Association
- accessibility to relevant multidisciplinary teams

Limiting factors in the CPG implementation include:

- limited awareness and understanding/knowledge in managing OSA among health care providers
- variation in clinical management and preferences
- insufficient resources in terms of budget, expertise, access to diagnostic tests, medications and treatment options
- misconception about the disease and its management by the public

6.2 Potential Resource Implications

OSA is a prevalent disease and underdiagnosed in Malaysia. It is a chronic disorder associated with several cardio-metabolic complications, neurocognitive impairment, increased motor vehicle accidents and reduced productivity when untreated. Hence, early diagnosis and prompt management of OSA can improve its outcomes.

As OSA is the commonest sleep-related breathing disorder, its management should be emphasised throughout all levels of care. Therefore, implementation of nation-wide screening among high-risk group e.g. with STOP-BANG questionnaire is important. Those at high risk should be provided with health education and advice on lifestyle modifications to prevent complications of the disease.

PSG is the gold standard to accurately diagnose OSA whilst CPAP is the mainstay of treatment. However, there is a lack of availability of sleep laboratories, as well as a scarcity of sleep specialists and trained sleep technologists in Malaysia. Provision of sleep laboratories, trained personnel and PAP therapy in managing OSA requires strong consideration and support from all stakeholders involved. Furthermore, the treatment cost may be high and not covered by insurance policies which will increase the burden on public services in providing effective treatment.

6.3 Clinical Audit Indicators

The following are proposed as clinical audit indicators for quality management of OSA:

- Percentage of patients with suspected of OSA with completed PSG (level 1, 2 or 3) within six months

$$= \frac{\text{Number of patients suspected of OSA with completed PSG (level 1, 2 or 3) within six months in a period}}{\text{Number of patients suspected of OSA in the same period}} \times 100\%$$

- Percentage of patients who receive PAP therapy within six months of OSA diagnosis

$$= \frac{\text{Number of patients who receive PAP therapy within six months of OSA diagnosis in a period}}{\text{Number of patients diagnosed with OSA in the same period}} \times 100\%$$

- Percentage of surgical success rate* of adult OSA patients (excluding bariatric surgery)

$$= \frac{\text{Number of successful surgeries of adult OSA patients (excluding bariatric surgery) in a period}}{\text{Number of surgeries done on OSA patients in the period}} \times 100\%$$

*reduction of AHI by 50% and AHI <20

Implementation strategies will be developed following the approval of the CPG by MoH which include launching of the CPG, Quick Reference and Training Module (available at: https://www.moh.gov.my/index.php/pages/view/3962?mid=1570).

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Appendix 1

EXAMPLE OF SEARCH STRATEGY

Clinical Questions: What are the safe and effective treatment options of OSA?

1. SLEEP APNEA, OBSTRUCTIVE/
2. (obstructive adj2 sleep apn#ea*).tw.
3. osahs.tw.
4. (obstructive adj3 sleep apn#ea syndrome).tw.
5. sleep apnea hypopnea syndrome.tw.
6. SLEEP APNEA SYNDROMES/
7. (sleep adj1 apn#ea*).tw.
8. (sleep apn#ea* adj2 syndrome*).tw.
9. ((sleep disordered or sleep-disordered) adj2 breathing).tw.
10. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11. CONTINUOUS POSITIVE AIRWAY PRESSURE/
12. ((bilevel or nasal) adj4 continuous positive airway pressure).tw.
13. (continuous adj3 positive airway pressure).tw.
14. (cpap adj1 ventilation).tw.
15. positive airway pressure.tw.
16. 11 or 12 or 13 or 14 or 15
17. 10 and 16
18. limit 17 to (english language and humans and yr=”2010 -Current”)

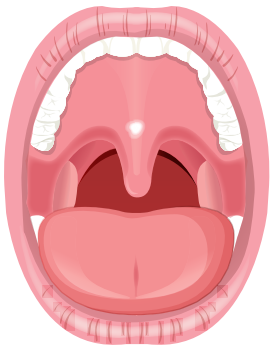
Appendix 2

CLINICAL QUESTIONS

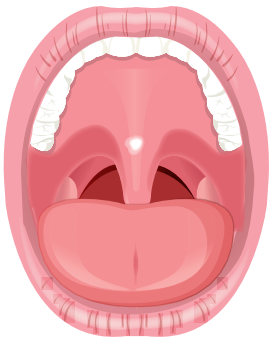
1. What is the prevalence/incidence of OSA?
2. Who are at risk of OSA?
3. What is the accuracy of the following screening tools for OSA?
   - Epworth Sleepiness scale
   - STOP-BANG
   - Berlin Questionnaire
   - TUCASA questionnaire
   - Trending of pulse oximetry (McGill oximetry scoring system)
   - Paediatric sleep questionnaire
4. What are the diagnostic criteria of OSA?
5. What are the indications for different levels of polysomnography in OSA?
6. What are the clinical assessments for OSA?
7. What are the co-morbidities associated with OSA?
8. What are the safety and effectiveness of the following treatment options for OSA?
   - weight management and lifestyle modification
   - Positive airway pressure therapy
   - surgical interventions
   - adjunctive therapy
     - oral devices
     - medications
9. What is the preoperative assessment of suspected and confirmed OSA?
10. What is the intraoperative management of suspected and confirmed OSA?
11. What is the postoperative management of suspected and confirmed OSA?
12. What are the parameters to be assessed at follow-up in OSA?
13. What are the indications to repeat sleep study assessment post-intervention of OSA?
14. What are the accurate diagnosis and effective treatment of OSA in the following conditions?
    - Pregnancy
    - Syndromic patients
    - Obesity hypoventilation disorder
15. What are the referral criteria of OSA to secondary/tertiary care?

Appendix 3

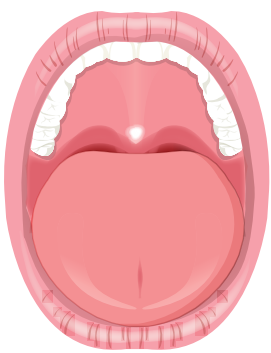
MODIFIED MALLAMPATI GRADING



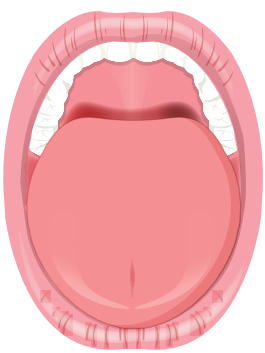
Grade 1
soft palate, fauces, uvula, anterior and posterior pillars visible



Grade 2
soft palate, fauces, uvula, visible



Grade 3
soft palate and base of uvula, visible

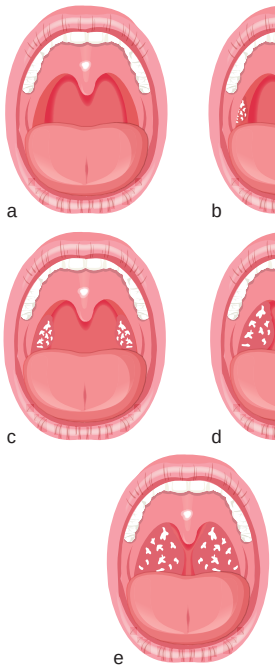


Grade 4
soft palate not visible

Adapted: Harvey R, O'Brien L, Aronovich S, et al. Friedman tongue position and cone beam computed tomography in patients with obstructive sleep apnea. Laryngoscope Investig Otolaryngol. 2017;2(5):320-324.

Appendix 4

TONSILLAR GRADING



a Size 0, absence of tonsillar tissue.
b Size 1, within the pillars.
c Size 2, extended to the pillars.
d Size 3, extended past the pillars.
e Size 4, extended to the midline.

Source: Friedman M, Salapatas AM, Bonzelaar LB. Updated Friedman Staging System for Obstructive Sleep Apnea. Adv Otorhinolaryngol. 2017;80:41-48.

Appendix 5

BERLIN QUESTIONNAIRE

1) Complete the following:
height_____ age_____
weight_____ male/female_____

2) Do you snore?
- ☐ yes
- ☐ no
- ☐ don't know

If you snore:

3) Your snoring is?
- ☐ slightly louder than breathing
- ☐ as loud as talking
- ☐ louder than talking
- ☐ very loud, can be heard in adjacent rooms

4) How often do you snore?
nearly everyday
- ☐ 3 - 4 times a week
- ☐ 1 - 2 times a week
- ☐ 1 - 2 times a month
- ☐ never or nearly never

5) Has your snoring ever bothered other people?
- ☐ yes
- ☐ no

6) Has anyone noticed that you quit breathing during your sleep?
- ☐ nearly everyday
- ☐ 3 - 4 times a week
- ☐ 1 - 2 times a week
- ☐ 1 - 2 times a month
- ☐ never or nearly never

7) How often do you feel tired or fatigued after you sleep?
- ☐ nearly everyday
- ☐ 3 - 4 times a week
- ☐ 1 - 2 times a week
- ☐ 1 - 2 times a month
- ☐ never or nearly never

8) During your wake time, do you feel tired, fatigued or not wake up to par?
- ☐ nearly everyday
- ☐ 3 - 4 times a week
- ☐ 1 - 2 times a week
- ☐ 1 - 2 times a month
- ☐ never or nearly never

9) Have you ever nodded off or fallen asleep while driving a vehicle?
- ☐ yes
- ☐ no

If yes, how often does it occur?
- ☐ nearly everyday
- ☐ 3 - 4 times a week
- ☐ 1 - 2 times a week
- ☐ 1 - 2 times a month
- ☐ never or nearly never

10) Do you have high blood pressure?
- ☐ yes
- ☐ no
- ☐ don't know

BMI =

Scoring Questions:	Any answer within box outline is a positive response.	☐
Scoring Categories:	Category 1 is positive with 2 or more positive responses to questions 2 - 6	☐
	Category 2 is positive with 2 or more positive responses to questions 7 - 9	☐
	Category 3 is positive with 1 or more positive responses and/or a BMI >30	
Final Results:	2 or more positive categories indicates a high likelihood of sleep disordered breathing.	

Reference: Netzer NC, Stoohs RA, Netzer CM, et al. Using the Berlin Questionnaire to identify patients at risk for the sleep apnea syndrome. Annals of internal medicine. 1999;131(7):485-491.

Appendix 6

STOP-BANG QUESTIONNAIRE

1 Snoring: Do you snore loudly (loud enough to be heard through closed doors)?
Yes No

2 Tired: Do you often feel tired, fatigued or sleepy during daytime?
Yes No

3 Observed: Has anyone observed you stop breathing during your sleep?
Yes No

4 Blood Pressure: Do you have or are you being treated for high blood pressure?
Yes No

5 BMI: BMI more than 35 kg/m2?
Yes No

6 Age: Age over 50 years old?
Yes No

7 Neck circumference: Neck circumference greater than 40 cm?
Yes No

8 Gender: Male?
Yes No

High risk of OSA: Yes to 3 or more questions
Low risk of OSA: Yes to less than 3 questions

Source: Chung F, Yegneswaran B, Liao P, et al. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. Anesthesiology. 2008;108(5):812-821.

Appendix 7

STOP-BANG QUESTIONNAIRE (MALAY VERSION)

STOP-BANG – Soal Selidik Apnea Tidur Obstruktif

No Rujukan Subjek: _____ Umur: _____ Jantina: L/P

1. Berdengkur	Ya/Tidak

Adakah anda kuat berdengkur (agak kuat sehingga boleh didengari walaupun di belakang pintu tertutup atau pasangan katil anda menyiku anda kerana berdengkur pada waktu malam)?

2. Letih	Ya/Tidak

Adakah anda sentiasa berasa penat, lesu atau mengantuk pada siang hari?
(contohnya tertidur semasa memandu)?

3. Diperhatikan	Ya/Tidak

Adakah sesiapa memerhatikan anda berhenti bernafas atau tercekik/ tercungap-cungap semasa sedang tidur?

4. Tekanan darah	Ya/Tidak

Adakah anda sedang diberi rawatan kerana penyakit darah tinggi?

5. Indeks berat badan	Ya/Tidak

Indeks berat badan lebih daripada 35 kg/m^2? (obes)

6. Umur	Ya/Tidak

Berumur lebih daripada 50 tahun?

7. Ukurlilit leher (diukur melalui halkum)	Ya/Tidak

Bagi lelaki, adakah ukuran kolar kemeja anda 17 inci/43 cm atau lebih luas?
Bagi wanita, adakah ukuran kolar kemeja anda 16 inci/41 cm atau lebih luas?

8. Jantina Lelaki	Ya/Tidak

MARKAH: **RISIKO OSA:**

Kriteria pemarkahan Untuk populasi umum

Risiko rendah terhadap apnia tidur obstruktif (OSA): Ya kepada 0-2 soalan
Risiko pertengahan terhadap OSA: Ya kepada 3-4 soalan
Risiko tinggi OSA: Ya kepada 5-8 soalan
Atau
Ya kepada 2 atau lebih daripada 4 terhadap soalan STOP + jantina lelaki
Atau
Ya kepada 2 atau lebih daripada 4 terhadap Soalan STOP + index berat badan >35 kg/m^2
Atau
Ya kepada 2 atau lebih daripada 4 terhadap soalan STOP + ukurlilit leher 17”/43 cm bagi lelaki, 16”/41 cm bagi wanita

Reference: Abdullah B, Idris AI, Mohammad ZW, et al. Validation of Bahasa Malaysia STOP-BANG questionnaire for identification of obstructive sleep apnea. Sleep Breath. 2018;22(4):1235-1239.

Appendix 8

EPWORTH SLEEPINESS SCALE

Name:_____ **Today's date**:_____

Your age (Yrs): _____**Your sex (Male = M, Female = F)**: _____

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired?

This refers to your usual way of life in recent times.

Even if you haven't done some of these things recently try to work out how they would have affected you.

Use the following scale to choose the most appropriate number for each situation:

0 = **would never** doze
1 = **slight chance** of dozing
2 = **moderate chance** of dozing
3 = **high chance** of dozing

It is important that you answer each question as best as you can.

Situation	**Chance of Dozing (0-3)**
Sitting and reading	
Watching TV	
Sitting, inactive in a public place (e.g. a theatre or a meeting	
As a passenger in a car for an hour without a break	
Lying down to rest in the afternoon when circumstances permit	
Sitting and talking to someone	
Sitting quietly after a lunch without alcohol	
In a car, while stopped for a few minutes in the traffic	

Reference: Johns MW. A new method for measuring daytime sleepiness: the Epworth Sleepiness Scale. Sleep, 1991; 14: 50-55.

Appendix 9

ASA PHYSICAL STATUS CLASSIFICATION SYSTEM

Committee of Oversight: Economics
(Approved by the ASA House of Delegates on October 15, 2014, and last amended on December 13, 2020)

The ASA Physical Status Classification System has been in use for over 60 years. The purpose of the system is to assess and communicate a patient's pre-anesthesia medical co-morbidities. The classification system alone does not predict the perioperative risks, but used with other factors (e.g. type of surgery, frailty, level of deconditioning), it can be helpful in predicting perioperative risks.

The definitions and examples shown in the table below are guidelines for the clinician. To improve communication and assessments at a specific institution, anesthesiology departments may choose to develop institutional-specific examples to supplement the ASA-approved examples.

Assigning a Physical Status Classification level is a clinical decision based on multiple factors. While the classification may initially be determined at various times during the preoperative assessment of the patient, the final assignment of Physical Status Classification is made on the day of anaesthesia care by the anaesthesiologist after evaluating the patient.

ASA PS Classification	Definition	Adult examples, including but not limited to:	Paediatric examples, including but not limited	Obstetric examples, including but not limited to:
ASA I	A normal healthy patient	Healthy, non-smoking, no or minimal alcohol use	Healthy (no acute or chronic disease), normal BMI percentile for age	
ASA II	A patient with mild systemic disease	Mild diseases only without substantive functional limitations. Current smoker, social alcohol drinker, pregnancy, obesity (30<BMI<40), well-controlled DM/HTN, mild lung disease	Asymptomatic congenital cardiac disease, well-controlled dysrhythmias, asthma without exacerbation, well-controlled epilepsy, non-insulin dependent DM, abnormal BMI percentile for age, mild/moderate OSA, oncologic state in remission, autism with mild limitations	Normal pregnancy*, well-controlled gestational HTN, controlled preeclampsia without severe features, diet-controlled gestational DM
ASA III	A patient with severe systemic disease	Substantive functional limitations; one or more moderate to severe diseases. Poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), active hepatitis,	Uncorrected stable congenital cardiac abnormality, asthma with exacerbation, poorly-controlled epilepsy, insulin dependent DM, morbid obesity, malnutrition, severe OSA,	Preeclampsia with severe features, gestational DM with complications or high insulin requirements, a thrombophilic disease requiring anticoagulation

ASA PS Classification	Definition	Adult examples, including but not limited to:	Paediatric examples, including but not limited	Obstetric examples, including but not limited to:
		alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly-scheduled dialysis, history (>3 months) of MI, CVA, TIA or CAD/stents	oncologic state, renal failure, muscular dystrophy, cystic fibrosis, history of organ transplantation, brain/ spinal cord malformation, symptomatic hydrocephalus, premature infant post-conceptual age <60 weeks, autism with severe limitations, metabolic disease, difficult airway, long term parenteral nutrition. Full term infants <6 weeks of age.	
ASA IV	A patient with severe systemic disease that is a constant threat to life	Recent (<3 months) MI, CVA, TIA or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, shock, sepsis, DIC, ARD or ESRD not undergoing regularly-scheduled dialysis	Symptomatic congenital cardiac abnormality, congestive heart failure, active sequelae of prematurity, acute hypoxic-ischemic encephalopathy, shock, sepsis, disseminated intravascular coagulation, automatic implantable cardioverter-defibrillator, ventilator dependence, endocrinopathy, severe trauma, severe respiratory distress, advanced oncologic state	Preeclampsia with severe features complicated by HELLP or other adverse event, peripartum cardiomyopathy with EF <40, uncorrected/ decompensated heart disease, acquired or congenital
ASA V	A moribund patient who is not expected to survive without the operation	Ruptured abdominal/ thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction	Massive trauma, intracranial hemorrhage with mass effect, patient requiring ECMO, respiratory failure or arrest, malignant hypertension, decompensated congestive heart failure, hepatic encephalopathy, ischemic bowel or multiple organ/system dysfunction	Uterine rupture
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes			

* Although pregnancy is not a disease, the parturient' s physiologic state is significantly altered from the woman is not pregnant, hence the assignment of ASA 2 for a woman with uncomplicated pregnancy

**the addition of "E" denotes emergency surgery (an emergency is defined as existing when delay in treatment of the patient would lead to a significant increase in the threat to life or body part)

Reference: American Society of Anesthesiologists, ASA Physical Status Classification System. 2020. [Available at: https://www.asahq.org/standards-and-guidelines/asa-physical-status-classification-system]

Appendix 10

PAEDIATRIC SLEEP QUESTIONNAIRE

22 items in PSQ	Score	
	No=0	Yes=1
While sleeping, does your child….		
• snore more than half the time?		
• always snore?		
• snore loudly?		
• have `heavy' or `loud breathing?		
• have trouble breathing or struggle to breath?		
Have your ever…		
• seen your child stop breathing during the night?		
Does your child…		
• tend to breath through the mouth during the day?		
• have a dry mouth on waking up in the morning?		
• occasionally wet the bed?		
Does your child…		
• wake up feeling unrefreshed in the morning?		
• have a problem with sleepiness during the day?		
• has a teacher or other supervisor commented that your child appears sleepy during the day?		
• is it hard to wake your child up in the morning?		
• does your child wake up with headaches in the morning?		
• did your child stop growing at a normal rate at any time since birth?		
• is your child overweight		
This child often…		
• does not seem to listen when spoken to directly		
• has difficulty organizing task and activities		
• is easily distracted by extraneous stimuli		
• fidgets with hands or feet or squirms in seat		
• is `on the go' or often acts as if `driven by a motor'		
• interrupts or intrudes on others (e.g. butts into conversations or games)		
Total number of "Yes"score		
Indicate sleep related breathing disorder (Score ≥8)		

Responses are "no" = 0, "yes" = 1, and "don't know"=missing.

Adapted: Chervin RD, Hedger K, Dillon JE, et al. Pediatric sleep questionnaire (PSQ): validity and reliability of scales for sleep-disordered breathing, snoring, sleepiness, and behavioral problems. Sleep Med. 2000:1;1(1):21-32.

Appendix 11

PAEDIATRIC SLEEP QUESTIONNAIRE (MALAY VERSION)

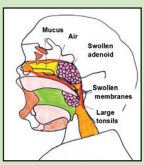
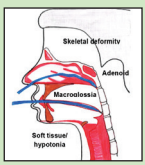
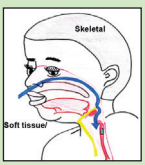
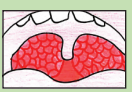
22 item PSQ (BM)	Skor	
	Tidak=0	Ya=1
Ketika tidur, adakah anak anda…		
• berdengkur lebih daripada separuh masa tidurnya?		
• sentiasa berdengkur		
• berdengkur dengan kuat?		
• bernafas dengan “panjang” dan “dalam”?		
• mengalami masalah pernafasan atau sukar hendak bernafas?		
Pernahkah anda …		
• melihat anak anda berhenti bernafas *seketika* pada waktu tidur?		
Adakah anak anda…		
• lebih cenderung bernafas melalui mulut pada siang hari?		
• mengalami mulut kering ketika bangun pagi?		
• sekali sekala terkencing di atas katil ketika tidur?		
Adakah anak anda ….		
• berasa kurang segar ketika bangun pagi		
• menghadapi masalah mengantuk pada siang hari?		
• pernah diberitahu oleh guru atau penyelia bahawa anak anda kelihatan mengantuk pada waktu siang?		
• sukar dibangunkan dari tidur pada waktu pagi?		
• mengadu sakit atau pening kepala ketika bangun tidur?		
• mengalami masalah terbantut tumbesaran atau pembesaran?		
• mengalami berat badan berlebihan?		
Kanak-kanak……		
• selalunya seperti tidak mendengar apabila bercakap dengannya secara berdepan		
• selalu mengalami kesukaran mengatur tugas dan aktiviti		
• selalu terganggu dengan rangsangan luar		
• kelihatan resah dan sentiasa menggerakan jari tangan atau kakinya atau gelisah ketika duduk		
• terlampau aktif atau tidak boleh duduk diam		
• selalu menyampuk cakap orang atau mengganggu orang (contohnya, mencelah perbualan orang lain atau mengganggu permainan).		
Jumlah skor “Ya”		
Mencadangkan masalah pernafasan berkaitan tidur (Sleep disordered breathing) Skor ≥8		

Respon “Tidak” = 0, “Ya=1” dan “tidak tahu”=”missing”

Reference: Hasniah AL, Jamalludin AR, Norrashidah AW, et al. Cross-cultural adaptation and reliability of pediatric sleep questionnaire in assessment of sleep-disordered breathing in the Malay speaking population. World J Pediatr. 2012;8(1):38-42.

Appendix 12

MECHANISM OF AIRWAY OBSTRUCTION AND PRINCIPLE OF MANAGEMENT IN CHILDREN

		SITE OF AIRWAY OBSTRUCTION		
		NASO-PHARYNX	*ORO-PHARYNX*	*LARYNGO-PHARYNX (HYPO-PHARYNX)*
MECHANISM OF AIRWAY OBSTRUCTION: *NARROWING OF AIRWAY DUE TO SOFT TISSUE, BONE, CARTILAGE OR NEUROMUSCULAR DISORDER*				  *Epiglotis, vocal cord*
PRINCIPLES OF MANAGEMENT		***NASO-PHARYNX***	***ORO-PHARYNX***	***LARYNGO-PHARYNX (HYPO-PHARYNX)***
SURGERY	**CORRECTIVE SURGERY**	 Craniosynostosis e.g. Crouzon Syndrome  Maxilliofacial Pierre Robin Sequence **Surgery:** **Bone advancement** e.g. Mandibular distraction osteogenesis, rapid maxillary expansion  Nasal septum deviation Surgery: **Septoplasty**	 Tonsillar hypertrophy surgery: **Tonsillectomy**  AV malformation e.g. Cystic hygroma Surgery: **Resection**	 Laryngomalacia Surgery: **Supraglottoplasty**
	RELIEF OF OBSTRUCTION	 Adenoid hypertrophy Surgery: **Adenoidectomy**  Adenotonsillar hyperthrophy Surgery: **Adenotonsillectomy**  Nasal polyp Surgery: **Polypectomy**	 Veno-lymphatic malformation Surgery: **Resection**	 Laryngomalacia Surgery: **Supraglottoplasty**
	BYPASS AIRWAY OBSTRUCTION	 Choanal atresia Surgery: **Tracheostomy**	 Pierre Robin Sequence Surgery: **Tracheostomy**  Veno-lymphatic malformation Surgery: **Tracheostomy**	 Severe Obesity Surgery: **Tracheostomy**  Spasticity e.g. Cerebral Palsy Surgery: **Tracheostomy**

<table>
<tr><td rowspan="2">MEDICAL</td><td>REDUCE OEDEMA AND INFLAMMATION</td><td> 
Allergic rhinitis
Treatment:
<u>Anti-inflammatory drugs</u>
e.g. nasal corticosteroids, montelukast, anti-histamines</td><td></td><td></td></tr>
<tr><td>CONTROL DISEASE</td><td></td><td></td><td> 
<u>Subglottic hemangioma</u>
Treatment: <u>Propanolol</u></td></tr>
<tr><td rowspan="3">CPAP</td><td>RELIEVE AIRWAY OBSTRUCTION</td><td></td><td> 
<u>Maxillofacial e.g. Pierre Robin</u> Sequence
Treatment: CPAP
 
<u>Metabolic diseases</u> e.g. Mucopoly-sacharidoses
Treatment: CPAP</td><td> 
<u>Mild to moderate laryngomalacia</u>
Treatment: <u>CPAP</u></td></tr>
<tr><td>SPLINT CROWDED AIRWAY</td><td></td><td> 
<u>Macroglossia e.g. Beckwidth Wiederman Syndrome</u>
Treatment: CPAP
 
<u>Down's Syndrome</u>
Treatment: CPAP</td><td> 
<u>Obesity</u>
Treatment: <u>CPAP</u></td></tr>
<tr><td>SPLINT HYPOTONIC AIRWAY</td><td></td><td></td><td> 
<u>Hypotonia e.g.</u> Down's / Neuromuscular diseases
Treatment: CPAP</td></tr>
</table>

Illustration: Norhazirah Mohd Razali *Concept: Mohd Yusran Othman and Asiah Kassim*

LIST OF ABBREVIATIONS

AASM	American Academy of Sleep Medicine
AE(s)	adverse event(s)
AHI	Apnoea-Hypopnoea Index
AI	Arousal index
ALT	Alanine Transaminase
ANB	difference between SNA and SNB, where SNA is the angle between
	sella, nasion and A point, while SNB is the angle between sella,
	nasion and B point
APAP	automated positive airway pressure
ARD	acute respiratory distress
ASA	American Society of Anesthesiologists
AST	Aspartate Aminotransferase
AT	adenotonsillectomy
ATS	American Thoracic Society
AUC	area under the curve
BiPAP	bi-level PAP
BMI	body mass index
BRP	barbed reposition pharyngoplasty
BQ	Berlin Questionnaire
CA	craniofacial anomalies
CAD	coronary artery disease
CHD	cardiovascular disease
CI	confidence interval
CKD	chronic kidney disease
COPD	chronic obstructive pulmonary disease
CPAP	continuous positive airway pressure
CV	cardiovascular
CrI	Credible interval
CVA	cerebrovascular accident
CVD	cardiovascular disease
DG	Development Group
DIC	disseminated intravascular coagulation
DISE	drug-induced sleep endoscopy
DM	diabetes mellitus
DOME	distraction osteogenesis maxillary expansion
DTA	diagnostic test accuracy
DS	Down syndrome
ECG	electrocardiogram
ECMO	extracorporeal membrane oxygenation
EEG	electroencephalogram
EF	ejection fraction
EMG	electromyogram
EOG	electrooculogram
ESRD	end-stage renal disease
ESS	Epworth Sleepiness Scale
FNMM	fiber-optic nasal endoscopy with Muller's Manoeuver
ERS	European Respiratory Society
HELLP	Hemolysis, Elevated Liver Enzymes and Low Platelets
HPE	histopathology examination
HSAT	home sleep apnea testing
HTN	hypertension

ICSD-3	The third edition of the International Classification of Sleep Disorders
ICU	intensive care unit
LAUP	laser-assisted uvulopalatoplasty
LSAT	lowest oxygen saturation
MAA	mandibular advance appliance
MD	mean difference
MI	myocardial infarction
MMA	maxillomandibular advancement
MP-SN	angle between mandibular plane and sella nasion line
NOSE	nasal obstruction symptom evaluation
NIV	noninvasive ventilation
ODI	oxygen desaturation index
ODI_4	Oxyhaemoglobin desaturation (≥4%) index
OHS	Obesity Hypoventilation Syndrome
OSA	Obstructive Sleep Apnoea
OR	odds ratio
ORID	opioid-induced respiratory depression
ORL	otorhinolaryngology
$PaCO_2$	arterial carbon dioxide tension
PACU	Post-Anaesthesia Recovery Unit
PAP	positive airway pressure
PAV	posterior airway volume
PM	portable monitor
PNS-AD1	distance from the posterior nasal spine to the nearest adenoid tissue
	measured along the PNS- basion line
PNS-AD2	distance from the posterior nasal spine to the nearest adenoid tissue
	measured along the line perpendicular to the sella-basion line
PPV	positive predictive value
PRS	Pierre Robin Sequence
PSG	polysomnogram
PSQ	Pediatric Sleep Questionnaire
P-SAP	perioperative sleep apnea prediction
QoL	quality of life
RCT(s)	randomized controlled trial(s)
RDI	Respiratory Disturbance Index
RME	rapid maxillary expansion
REM	rapid eye movement
ROC	receiver operating characteristic
RR	relative risk
SARPE	surgical-assisted rapid palatal expansion
SBQ	STOP-BANG Questionnaire
SBP	systolic blood pressure
SDB	sleep disordered breathing
SMD	standardised mean difference
SNB	angle between sella, nasion and B point
SE(s)	side effect(s)
SpO_2	Oxygen saturation
SQ	STOP Questionnaire
T2DM	type 2 diabetes mellitus
TCRFTA	temperature controlled radiofrequency tissue ablation
TIA	transient ischaemic attack
TIVA	total IV anaesthesia
TMJ	temporomandibular joint

TORS BOT	transoral robotic base-of-tongue surgery
vs	versus
WMD	weighted mean difference

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