

Perioperative pulmonary complications: can they be predicted and minimized?

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Abstract

Patients undergo surgery for various reasons. A main concern for the surgeon and anaesthetist is the occurrence of pulmonary complications during and after surgery. Perioperative pulmonary complications are more frequent in patients with compromised pulmonary function. If there is a possibility to predict such complications, necessary precautions could be taken, and the patients could be optimized to ensure that such complications are minimized. A better understanding of the physiological changes and risk factors predisposing to perioperative pulmonary complications is essential to develop strategies for reducing these complications. The resulting reduction in morbidity and mortality would lead to improvement of quality of life and reduced costs.

This article aims to make the surgeon aware of the possible surgery and anaesthesia related physiological derangements, and human and environmental factors in the operating theatre that can contribute to perioperative respiratory complications in patients undergoing surgery that is not directly related to the lungs. It stresses on the importance of actively looking for unseen and underlying physiological, pathological, patient and drug related factors to minimize perioperative pulmonary complications, highlighting important considerations in patients with underlying pulmonary disease.

Introduction

Annually approximately 300 million people undergo surgery worldwide [1]. Perioperative pulmonary complications are a cause of significant morbidity and mortality with such patients having longer duration of hospital stay. They occur more frequently than cardiac complications [2]. Such complications arise due to patient factors and effects of surgical procedures, anaesthesia, the surgical environment or pharmacological interventions during the procedure [3]. Poor pain relief, sedation and increased ventilatory demands

in the cold environment exacerbate these effects [4, 5]. When the load on the respiratory system exceeds capacity, failure will occur.

The risk for perioperative pulmonary complications depends on the site of surgery and whether it is elective or emergency surgery. The risk increases if the patient has underlying comorbidities and pre-existing pulmonary diseases such as asthma, interstitial lung disease (ILD), chronic obstructive pulmonary disease (COPD) and obstructive sleep apnoea (OSA) and, if the surgical process is directly related to the pulmonary system [5, 6]. These risks are more in extremes of age, obesity and smokers [5]. Other commonly overlooked risk factors in the 'apparently healthy' are atopy [7] and gastro-oesophageal reflux disease (GORD) [8]. The risk of postoperative complications can be reduced by postponement of surgery in patients who have reaspiratory infections or have incompletely treated pulmonary disease or comorbidities [6].

This article provides answers to frequently asked questions regarding perioperative pulmonary complications and also discusses special considerations in patients with respiratory infections including COVID-19 and tuberculosis, OSA and those on long term steroid use.

What are the commonly occurring perioperative pulmonary complications?

These include hypoxaemia, atelectasis, aspiration pneumonitis, bronchospasm, pleural effusion, pneumothorax, pneumonia, exacerbation of pre-existing pulmonary conditions, respiratory infections, pulmonary embolism, acute respiratory distress syndrome and respiratory failure [5, 9].

How does surgery affect pulmonary function?

Direct or indirect effects of surgery can lead to respiratory muscle dysfunction. Location of surgical incisions, length of the surgery, post-surgical deconditioning, procedures causing neurological damage or dysfunction can lead to respiratory muscle dysfunction, reducing tidal volume (TV), vital capacity (VC), and total lung capacity (TLC) [4, 10]. Insufficient cough and insufficient inspiratory effort due to pain following surgery can lead to atelectasis, reduce

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functional residual capacity and lead to ventilation-perfusion mismatch. Atelectasis is a factor that predisposes to pulmonary infections [5, 11]. However, procedures such as lung transplantation and lung volume reduction may actually improve the function of the respiratory muscles and oxygenation [12].

Surgeries that are considered as high risk to the patient include thoracic surgery, abdominal surgery (upper more than lower), aortic aneurysm repair, neurological surgery, vascular and head and neck surgeries. Surgery where the duration exceeds two hours and emergency procedures also increase the risk of pulmonary adverse events [5, 13].

What are the physiological derangements in pulmonary function that may occur during anaesthesia?

Physiological derangements are more common during general anaesthesia (compared to regional anaesthesia) and with use of long-acting muscle relaxants. Inspiratory capacity and expiratory reserve are reduced and cough efficiency temporarily decreased during high lumbar and thoracic segment blockage [14]. Physiological derangements that arise as a consequence of general anaesthesia are given in table 1. These include effects of intubation, anaesthetic agents and effects attributable to the patient's position during anaesthesia [5, 11, 14].

How can perioperative pulmonary complications be predicted?

A thorough preoperative medical history and physical examination combined with investigations are important steps that help identify risk factors associated with perioperative pulmonary complications [13]. Preoperative risk stratification using risk prediction models takes into consideration non-modifiable and modifiable risk factors (based on history and examination), type of surgery and preoperative investigations. ARISCAT (Assess Respiratory Risk In Surgical patients in Catalonia) and PERISCOPE (Prospective Evaluation of a Risk Score for postoperative pulmonary complications in Europe) are such models [5]. However, first time drug allergy or errors in drug administration can very rarely occur during surgery despite thorough preoperative assessment [15].

What are the patient-related factors that increase risk of perioperative pulmonary complications?

Important information to be elicited by a thorough medical history is given in table 2, including demographic parameters, symptoms, exposure and habits, exercise capacity, and presence of comorbidities and allergies. Often overlooked conditions such as atopy, wheezing (in childhood, in response to infections or cold) and GORD need to be specifically sought [5, 7, 8, 13, 14].

What are the important features that should be looked for during physical examination?

A thorough examination of general appearance and the cardiorespiratory system is essential, including measurement of height and weight [5,13]. Important features to note are mentioned in table 3.

What are the investigations that assist in predicting perioperative pulmonary complications? [5, 12, 14]

Table 4 lists investigations that are routinely performed to predict risk of perioperative complications in high risk surgeries and in those with compromised pulmonary systems [5, 13]. Prior to performing such investigations, factors such as whether the outcome would influence the decision to postpone or cancel surgery, the risk versus benefit and the cost of the test are taken into consideration.

Do pulmonary function tests (PFTs) need to be performed routinely before surgery?

Routine spirometry assessment prior to surgery is generally not recommended in non-thoracic surgery or in individuals with no known or suspected pulmonary disease [16]. PFTs in these situations are unlikely to influence the decision whether the surgery should be performed or to alter perioperative management. The guidelines states that even patients who undergo major surgery and who are of American Society of Anesthesiologists (ASA) grade 3 or 4 because of known or suspected pulmonary disease should be tested only after seeking advice from a senior anaesthetist. Such patients are likely to have already undergone investigation or treatment by respiratory specialists. If they have not been assessed, then PFTs should be performed [16].

In surgeries where pulmonary parenchymal resection is planned, PFTs are of value. In pneumonectomy, preoperative spirometry, diffusing capacity (DLCO) and lung perfusion scintigraphy are used to calculate percent predicted postoperative values [12].

What PFTs are commonly performed to predict perioperative pulmonary complications?

Arterial blood gas analysis and oxygen saturation (SPO₂) estimation on room air, and spirometry are the most common PFTs to be performed prior to cardiothoracic surgery [12]. Spirometry which measures inhaled and exhaled lung volumes and flow over time, is used to diagnose airway obstruction and restriction and to grade severity in those with suspected pulmonary disease. A postbronchodilator FEV₁/FVC ratio of < 70% on spirometry confirms COPD in a patient with airway obstruction (GOLD criteria) and reversibility indicates asthma [17]. Spirometry is also combined with static lung volumes and DLCO values in risk assessment (table 5) [12]. An abnormal preoperative

Table 1. Physiological derangements due to general anaesthesia

Effect of anaesthesia	Physiological derangement
Endotracheal tube, mucosal swelling	increased airway resistance in upper airways
Reduced chest wall and diaphragm tone	atelectasis
Reduced tone of the upper airway muscles	airway collapse
Reduced lung compliance	increased work of breathing
Supine or lateral position Surgery	reduced tidal volume and functional residual capacity early airway closure V/Q mismatch
Sedation from opioids or hypercapnia	Central respiratory depression
Prolonged exposure to anaesthetics	Impairment of ventilatory response to hypoxia and hypercapnia and acidosis Inhibition of hypoxic pulmonary vasoconstriction Depression of cough reflex Temporary immunosuppression and decreased mucociliary clearance
Bronchodilation/ bronchoconstriction	

Table 2. Patient-related factors that increase the risk of perioperative complications

	Patient factor
Physiological factors	Extremes of age and pregnancy
Symptoms	Cough, shortness of breath (at rest and in response to activity), dyspnoea, recent infections (within 1 month) Daytime sleepiness, snoring, episodes of observed apnoea Increasing (fluid retention) or decreasing weight (malnutrition/protein deficiency/>10% weight loss in the preceding 6 months) Cardiac angina
Exposure	Pulmonary toxic medications (bleomycin, amiodarone, etc.) Environmental/occupational contamination (coal dust, secondhand smoke, asbestos, etc.) Tobacco use/ exposure to secondhand smoke fuel Alcohol use
Exercise capacity	Inability to perform activities of daily living without assistance or live independently Self- estimate of ability to climb 2 flights of stairs or walk approximately 0.4 miles or 350-400 m at a reasonable pace (3.5 miles/h) without shortness of breath is essential for elective surgery Features of heart failure
In the apparently normal	Atopy (known or suspected), childhood wheezing, allergic rhinitis, syncopal attacks, gastro oesophageal reflux, exercise or cold induced wheezing or cough
Allergies	History of known or suspected allergies
Comorbidities	COPD, asthma Long term steroid use Congestive heart failure Metabolic abnormalities Neuromuscular defects Obstructive sleep apnoea Obesity Diabetes mellitus Hypertension Malignancies Chronic liver disease Renal failure Endocrine disorders Pulmonary hypertension

Table 3. Physical signs to be observed to predict risk of perioperative complications

General appearance	Muscle wasting, size of oral opening, visibility of uvula and palate, mobility of cervical spine, condition of teeth, thyromental distance, neck circumference, digit clubbing, cyanosis, shape of the thorax
Height and weight	Body mass index
Respiratory system	A thorough airway examination: respiratory rate and pattern respiratory effort during conversation and with movement, signs and symptoms of obvious lung and lung related conditions, diminished respiratory sounds, dullness to percussion, laryngeal height, Positive cough test (where the patient coughs involuntarily after deep inspiration)
Cardiovascular system	Features of heart failure

Table 4. Investigations performed to predict risk of perioperative complications

Blood tests	Serum eosinophils Serum total IgE Blood urea Serum haemoglobin Serum albumin Serum creatinine Liver function tests
Radiology	Chest radiograph Lung computerized tomographic scan (especially High-resolution CT) and MRI are performed only if there is clinical suspicion of a condition that could affect decision-making in the perioperative period
Pulmonary function tests	See table 5 and 6

Table 5. Spirometry parameters and information obtained useful in assessment of suitability for surgery

Parameter	
Reduced FVC, VC or TLC	Indicative of restrictive disease
FEV ₁ /FVC ratio <70% and FEV ₁ <80% of predicted	Indicative of obstructive lung disease
Post bronchodilator FEV ₁ /FVC ratio of <0.70	Diagnostic of COPD
Obstructive spirometry values and reduced DLCO	Indicative of emphysema
Maximal voluntary ventilation	To assess exercise tolerance and respiratory muscle endurance
Flow volume loops*	To evaluate airway obstruction To differentiate between fixed and variable (intra- and extra thoracic) obstruction

FVC, Forced Vital Capacity VC, Vital Capacity TLC, Total Lung Capacity

FEV₁, Forced Expiratory Volume in the first second of FVC

FEV₁/FVC, Ratio of FEV₁ to FVC

DLCO, Diffusing Capacity of the Lung for Carbon Monoxide

*These can be helpful in the workup of patients with unexplained dyspnoea, stridor, suspected tracheal stenosis and vocal cord pathology

Table 6. Protocol for the preoperative objective assessment of COVID-19 survivors, stratified based on nature of planned surgery and degree of index illness [24].

Step/ test	Minor procedures and/or without general anaesthesia		Major procedures	
	Asymptomatic	Symptomatic	Asymptomatic	Symptomatic
CXR	No—if pulmonary exam and SpO ₂ normal	No—if pulmonary exam and SpO ₂ normal	Yes	Yes
ECG	Yes	Yes	Yes	Yes
Echo	No—if cardiac exam and vitals normal	No—if cardiac exam, NT-pro-BNP, and vitals normal	No—if cardiac exam, NT-pro-BNP, and vitals normal	Determined by H&P
CMP	Yes	Yes	Yes	Yes
FBC with DC	Yes	Yes	Yes	Yes
PTT	No	Consider based on severity of illness	Yes	Yes
D-dimer	No	Yes	Yes	Yes
Fibrinogen	No	Consider based on severity of illness	Yes	Yes
NT-Pro-BNP	No	Yes	Yes	Yes
LDH, Ferritin, prealbumin	No	Consider based on severity of illness	No	Consider based on severity of illness

CXR, Chest X ray

H&P, History and physical examination

CMP, Comprehensive metabolic panel

NT-Pro-BNP, N-terminal (*NT*)-*pro* hormone brain type natriuretic peptide

ECG, Electrocardiogram

DC, Differential count

PTT, Prothrombin time

Echo, Echocardiogram

FBC, Full blood count

LDH, lactate dehydrogenase

Table 7. Perioperative steroid management in patients on high doses of steroids for interstitial lung disease or sarcoidosis, requiring surgery [34]

	Intra-operative steroid replacement	Postoperative steroid replacement
Major surgery	Hydrocortisone 100 mg intravenously at induction, followed by immediate initiation of a continuous infusion of hydrocortisone at 200 mg.24 h ⁻¹ ; Alternatively, dexamethasone 6–8 mg intravenously, if used, will suffice for 24 h	Hydrocortisone 200 mg.24 h ⁻¹ by iv infusion while nil by mouth (alternatively, hydrocortisone 50 mg every 6 h by im injection) Resume enteral glucocorticoid at double the pre-surgical therapeutic dose for 48 h if recovery is uncomplicated. Otherwise continue double oral dose for up to a week
Body surface and intermediate surgery	Hydrocortisone 100 mg, intravenously at induction, followed by immediate initiation of a continuous infusion of hydrocortisone 200 mg.24 h ⁻¹ Alternatively, dexamethasone 6–8 mg intravenously, if used, will suffice for 24 h	Double regular glucocorticoid dose for 48 h, then continue usual treatment dose if uncomplicated
Bowel procedures requiring laxatives/enema	Continue normal glucocorticoid dose. Equivalent iv dose if prolonged nil by mouth	
Labour and vaginal delivery	Hydrocortisone 100 mg intravenously at onset of labour, followed by immediate initiation of a continuous infusion of hydrocortisone 200 mg.24 h ⁻¹ Alternatively, hydrocortisone 100 mg intramuscularly followed by 50 mg every 6 h intramuscularly	
Caesarean section	See major surgery	

spirometry result alone should not deter patient from undergoing planned surgery. In such an event, assessment of risks versus benefits in consultation with relevant specialists should be done [16].

What are the other PFTs that are useful in pre-operative assessment in a patient with known or suspected pulmonary disease?

Static lung volumes are useful to detect hyperinflation of the chest in patients with COPD and DLCO helps to differentiate intrinsic from extrinsic restrictive (neuromuscular, chest wall and pleural) disease. Exercise tests such as six-minute walk test (6MWT), incremental shuttle test and cardiopulmonary exercise testing (CPET) assess the exercise capacity of an individual and indicate the physiological cardiorespiratory reserve that may be available after surgery. Maximal inspiratory and expiratory pressures (MIPs and MEPs) and sniff nasal inspiratory pressure (SNIP) are useful in assessment of respiratory muscle function. Bronchial challenge tests such as bronchoprovocation and exercise challenges are useful to detect compromised lung function in those with normal PFTs, yet with high clinical suspicion. For those who require air travel for surgery, it would seem prudent to assess fitness to fly [5, 6, 12].

How can perioperative pulmonary complications be minimized?

The following perioperative care interventions are carried out in clinical practice [3,5, 6, 7, 8, 14, 18], though some lack best quality evidence regarding reducing complications [18].

Box 1: Pulmonary function test parameters and reference values that indicate low risk for perioperative pulmonary complications [5, 6, 12, 13, 16]

FEV₁/FVC or FEV₁/VC >80%
FVC or VC >80% with <20% fall when subject lies supine
FEV₁ > 80%
MVV >50%
DLCO >=70%
MIP and MEP > 80cm H₂O
SNIP >70cm H₂O
SpO₂ >95%
VO₂max <20 ml/kg/min
Desaturation <4% with exercise

Before surgery

Identification of the “high-risk” patient

Preoperative optimization of comorbidities and respiratory infections

Optimal treatment for COPD, asthma, bronchiectasis and interstitial lung disease

Preoperative bronchodilator therapy in those with a FVC < 1 L or a FEV₁ < 500 cm³, especially if improvement occurs

after treatment.

Perioperative steroid management

Smoking cessation (at least 8 weeks prior to elective surgery)

Correction of anaemia

Preoperative respiratory muscle training

At the time of surgery

Adequate analgesia

Appropriate management of neuromuscular blocking drugs

Routine use of warming techniques

Intraoperative PEEP, ventilation regimes

Extubation in a sitting up posture (where possible)

Intraoperative use of antiemetics and prokinetics

After surgery

Early commencement of chest physiotherapy and steam inhalation

Oral hygiene

Early mobilization

Adequate pain relief

Appropriate fluid resuscitation and fluid balance

Continuation of patient's usual inhaler medication with added nebulizer as needed

Postoperative respiratory support with CPAP and nasal high-flow oxygen where required.

Is preoperative respiratory muscle training useful in prevention of postoperative pulmonary complications?

Improving respiratory muscle strength in patients undergoing thoracic surgery is beneficial, though there is limited effect on sustained ventilation and maximal oxygen consumption. Intermittent positive pressure breathing, incentive spirometry and deep breathing exercises are commonly utilized to prevent pulmonary complications after thoracic surgery [5, 6,].

How soon after respiratory infections can surgery be planned?

A patient with recent or ongoing upper or lower respiratory tract infection poses a dilemma in terms of timing of elective and emergency surgery. An upper respiratory tract infection (URI) in adults in the month before surgery was found to be have negative impact on postoperative outcome [19, 20], through either local or systemic effects.

Respiratory tract infections may make even normal individuals susceptible to laryngospasm, bronchial hyper-reactivity and bronchospasm, on exposure to anaesthetic gases or produce increased amounts of respiratory secretions for as long as 4-6 weeks after the infectious episode [19]. These patients are more prone to hypoxaemia, atelectasis,

collapse and pulmonary oedema increasing the risk of perioperative pulmonary complications [19]. Furthermore, a recent history of pneumonia was found to increase postoperative morbidity and mortality significantly when considering a variety of different surgical settings and patient groups [20]. In the case of general surgery, vascular surgery and thoracic surgery, special consideration needs to be given as these surgical types were reportedly most affected by preoperative pneumonia within a 30-day period [20]. Patients with acute lung infections should be adequately treated and postponement of elective surgery seriously considered until symptoms and lung function are back to acceptable levels [19, 20].

If an earlier date is required, the patient needs to be investigated similar to a known patient with asthma/bronchospasm. Sputum cultures need to be negative prior to performing PFTs, however, 6MWT is adequate to assess fitness for surgery if sputum is unavailable. In the patient requiring emergency surgery, however, it was found that in the case of preoperative pneumonia, emergency surgery showed only a mild increase in mortality [20]. The complications arising from increased airway reactivity can be minimized by using laryngeal mask airway (LMA) as an alternate technique to intubation, though it can still produce epiglottic irritation [21]. However, if intubation is mandatory, several options are available. The main treatment option advised is inhalation of sympathomimetics such as salbutamol [22]. Sympathomimetics produce more rapid and effective bronchodilation than the intravenous methylxanthine, aminophylline. Intravenous lignocaine (1.5–2 mg/kg), hydrocortisone (4 mg/kg) or glycopyrrolate (1 mg) has also been employed with good effect to help in reversing any reflex response to bronchoconstriction [22].

What is the optimal length of time between recovery from COVID-19 and elective surgery that would minimize perioperative complications?

A patient diagnosed with COVID-19 should be evaluated in regard to optimizing their medical conditions and physiologic status, if planning for surgery. Since COVID-19 has been found to affect multiple major organ systems, the timing of surgery after a diagnosis of COVID-19 is most important especially when considering the risk of peri-operative complications. Infection with COVID-19 that may have affected the lung parenchyma will manifest as restrictive lung disease and requires specific evaluation prior to planning surgery. Table 6 shows the protocol for objective preoperative assessment of COVID-19 survivors, based on the nature of surgery and degree of illness [23].

Given the current knowledge on the disease, the times to plan surgery after recovery from COVID-19 can be reasonably

estimated. The following time periods have been proposed as per literature to schedule elective surgery in patients diagnosed with and recovered from COVID-19 [23].

- Patient asymptomatic or recovered from only, mild respiratory symptoms – four weeks.
- Patient with respiratory symptoms not requiring admission – six weeks.
- Patient who has symptoms and is diabetic, immunocompromised and was hospitalized – eight to ten weeks.
- Patient who was managed in the ICU due to COVID 19 infection – twelve weeks.

The perioperative risk assessment should be individualised and factor in the type of surgery, patient comorbidities and benefit versus risk of delaying surgery [23]. Persisting symptoms, even 60 days beyond the diagnosis, such as breathlessness, fatigue and chest pain are common post COVID 19 infection. Furthermore COVID 19 may have long term effects on cardiac and respiratory function. Recovered COVID-19 patients with residual symptoms, therefore, should undergo a more thorough preoperative evaluation with special attention to the cardiopulmonary systems [24]

.In COVID-19 positive patients requiring emergency surgery, it is better to have a low threshold for intubation, especially in those who have acute respiratory failure. This should bypass non-invasive ventilation techniques (CPAP or BiPAP). This will minimize transmission risks [25]. Awake intubation techniques should be avoided. Procedures that may generate aerosolized particles have been associated with increased coronavirus transmission: eg. non-invasive ventilation, tracheal intubation, tracheostomy, and manual ventilation before intubation and bronchoscopy. An FFP3 mask should therefore be worn by all health care staff who are required to work in close proximity to the patient during these procedures [25].

What is the impact of pulmonary tuberculosis (PTB) on perioperative pulmonary complications in non-chest surgeries?

Patients with PTB are reported to have a higher risk of peri-operative complications compared to those without. These include, pneumonia, septicaemia and pulmonary embolism. Overall complications were also found to be higher [26]. Preoperative PTB was further associated with increased 30-day postoperative mortality, a prolonged hospital stay and increased rate of admission to intensive care units [26]. The reasons for this include the effects of PTB on pulmonary inflammation, altered innate immunity and complex drug interactions with anti TB medication [26].

When planning surgery for patients with PTB, a respiratory physician's opinion is invaluable. Patients with PTB become non-infectious at two weeks of anti-tuberculous treatment (ATT). After commencing treatment for PTB, sputum is examined for acid fast bacilli (AFB) and Mycobacterium tuberculosis (MTB) culture at two months when sputum smear conversion is expected [27]. Ideally, non-chest surgery, if elective, should be planned for after two months of commencing ATT [26, 27].

In the case of emergency surgery, a preoperative 6MWT in patients who are able, or oxygen saturation and ABG in patients who cannot perform 6MWT, is ideal as PFTs are contraindicated owing to PTB infection. Risk to the operating staff can be minimized by performing sputum AFB and rapid MTB culture as soon as surgery is planned, and by using personal protective equipment (PPE) and negative pressure environment for surgery [26, 27].

What is the effect of OSA on perioperative pulmonary complications?

Patients with OSA have a higher risk of perioperative pulmonary complications. Anaesthetic medication, opioids and other sedatives increase airway obstruction and hypoventilation, which in turn lead to hypercapnic respiratory failure [28]. Patients with OSA have an increased risk of being intubated postoperatively and a several-fold higher risk of being mechanically ventilated than those without OSA [28, 29]. There is also a higher risk of postoperative complications and admission to ICU as well as longer hospital stays than in those without OSA [29, 30].

OSA is generally undiagnosed, therefore, the use of the STOP-BANG questionnaire has been advised for pre-assessment screening. Depending on the results, the patient may either be referred for sleep studies and started on definitive management or recommended an alternative anaesthetic regime, for example, by using opioid sparing anaesthetic techniques and enhanced monitoring. This screening is recommended by the association of anaesthetists in the UK for all obese patients undergoing surgery [31]. Studies on obese OSA patients undergoing bariatric surgery have shown that such screening and management has improved post-surgical outcome including reduction in post-operative intensive care [28]. Screening also can predict susceptible patients who are either undiagnosed or who are resistant to continuous positive airway pressure treatment, thus enabling more intensive perioperative monitoring [28].

What is the perioperative steroid management in a patient on high doses of steroids for interstitial lung disease or sarcoidosis, requiring surgery?

Hypothalamo-pituitary adrenal axis (HPAA) suppression has

been seen in patients who take doses of prednisolone that exceed 5 mg/d long term, 7.5-10 mg/d for 1 month or 20 mg/d for 3 weeks. It is also seen in patients taking high doses of other inhaled corticosteroids for a variety of conditions [32]. Patients on such high doses of steroids at the time of planning for surgery require supplementation of corticosteroids in doses that should reflect the physiologic response of the normal adrenal gland to surgical stress. This supplementation should be for only a very short duration. Table 7 describes the perioperative steroid dosing recommendations based on the type of surgery [33, 34].

Conclusion

Perioperative pulmonary complications are common and more evident in those with compromised pulmonary function or undergoing surgery related to the pulmonary system. Knowledge of physiological derangements during surgery and anaesthesia, awareness and anticipation of human and environmental risk factors coupled with risk prediction and correction of modifiable risk factors could help minimize such complications.

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