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Evidence-based practice guidance on the perioperative care of Asthmatic surgical patient for a resource-constrained area. A Systematic Review Article

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ABSTRACT

Background: Bronchial Asthma is the prevalent co-existing disease among surgical patients requiring surgery. The significance of this guideline is to provide a proper preoperative evaluation, risk stratification, and optimization using a compilation of both pharmacological and non-pharmacological interventions, as well as intense intraoperative and postoperative adverse management. The present study is aimed to develop the evidence informed guidance on the perioperative care for asthmatic patients presenting for surgery.

Methods: The Reporting Items for Practice Guidelines in Health Care (RIGHT) protocols was used in reporting the review. An exhaustive search of the literatures was conducted by using the MeSH terms asthma OR bronchial asthma AND surgery OR elective surgery AND anesthesia OR general anesthesia OR regional anesthesia AND respiratory drugs OR bronchodilators, in the Cochrane Review, PubMed, and Google Scholar databases.

Result: 3,237 literatures were explored by from various databases by using the search strategies. 363 literatures were chosen following removal of duplicated literatures. 23 studies containing 253 articles were included; 6 Systematic reviews and meta-analysis, 5 observational studies, 8 RCTs, 2 non RCTs, and 2 reviewed articles quality were evaluated, and conclusion was drawn according to the levels of evidences and grade of recommendation.

Conclusion: Perioperative asthmatic management aimed at proper assessment, preoperative optimization with non-pharmacological measures like obtunding exposure to allergens and indoor pollution, environmental intervention like air purification, as well as healthy diet and exercise, which poses super outcomes when supported by pharmacological interventions. Before induction of anesthesia, low-dose IV ketamine, midazolam, lidocaine IV, or in combination with salbutamol can be safely used.

INTRODUCTION:

1.1. Background

Bronchial asthma is a chronic inflammatory disease of the small airways, characterized by airway inflammation and hyper-responsiveness resulting in episodic wheezing, coughing, breathlessness, chest tightness, and reversible airflow obstruction[1]. The etiology of asthma is a multifactorial condition, and its genesis is increasingly linked to interactions between genetic susceptibility, host factors, and environmental exposures. Included in them are host factors (obesity, nutritional deficiencies, infections, allergic sensitization), environmental variables (air pollution, pollen, mold, and other aeroallergens), and genetic factors (genetic loci associated with asthma susceptibility)[2].

Airway inflammation, modulation of airway tone, and reactivity are potential causes of asthma, even though their underlying mechanisms are still poorly understood. The possibility that asthma is a collection of heterogeneous phenotypes with various etiologies and prognoses rather than a single illness is also widely accepted[3]. The cornerstone of asthma exacerbations is airway inflammation, often triggered by viral infection, allergen exposure, and/or respiratory irritants. This airway inflammation sets up a vicious cycle of bronchial hyper-responsiveness and mucus hyper-secretion, leading to decreased expiratory flow[4].

1.2. Prevalence

With significant negative effects on both children's and adults' health, including high morbidity and mortality in severe cases, asthma is a serious non-communicable illness worldwide. Several studies revealed that the prevalence and severity of asthma are both rising globally, with variances between nations ranging from 0.7% to 18.4%[5].

1.3. Pathophysiology

Asthma's pathophysiological signature is a narrowing of the airway caused by smooth muscle spasm, vascular obstruction, bronchial wall edema, and persistent secretions. Epithelial shedding, sub-epithelial fibrosis, an increase in the quantity and density of mucous cells in the epithelium, airway smooth muscle hyperplasia and hypertrophy, and enhanced blood flow to the endothelial lining of the airways are all examples of airway remodeling[6]. Forced expiratory volume in one second (FEV1) declines as a result of these alterations in the extracellular matrix, smooth muscle, and mucous glands, which also result in decreased bronchial hyper-responsiveness[7]. Positive alveolar pressures at the end of expiration caused by resistance to expiratory airflow lead to air entrapment and hyperinflation of the lungs and thorax, increased labor of breathing, and altered respiratory muscle performance. Additionally, there are irregularities in the airflow blockage, which results in a mismatch between ventilation and perfusion and alterations in arterial blood gases[6,8].

1.4. General principles of asthma management: The objectives of asthma management are to establish effective symptom control, relieve symptoms when they arise, and reduce the risk of exacerbations, asthma-related death, chronic airflow restriction, and treatment-related side effects. A continuous cycle of assessment, treatment modification, and review should be used to customize and modify asthma care rather than applying a "one-size-fits-all" approach.

The three types of asthma drugs are controllers, relieves, and add-on therapies: Controllers include ICS, which lessen inflammatory reactions in the airways, manages symptoms, and lower the likelihood of exacerbations[9,10], especially in cases of moderate asthma[10-12], as well as of severe asthma[13-14].

Lung function losses brought on by exacerbations may be reduced by ICS treatment[15]. Controllers that are prescribed for daily usage are referred to as "maintenance" therapy. Rapid-onset bronchodilators are a component of relievers, such as SABA or low-dose ICS-formoterol. They are used "as needed" to provide prompt symptom relief, including in exacerbations. When compared to a SABA reliever, using ICS-formoterol (commonly referred to as an "anti-inflammatory reliever" or "AIR") as a reliever lowers the risk of severe exacerbations whether maintenance controller treatment is used[16,17] or not[11,12]. To avoid exercise-induced bronchoconstriction, SABA or ICS-formoterol are also advised before exercise[18,19]

Patient with bronchial asthma may undergo surgery for numerous purposes. No matter the anesthesia techniques used, perioperative respiratory adverse events such as bronchospasm, laryngospasm, desaturation, coughing, and excessive secretion can happen at any point throughout the anesthetic course[3].

Patient with bronchial asthma facing surgery is categorized either poorly or optimally controlled group. In comparison to those with controlled asthma, those with a history of uncontrolled (poorly managed) asthma three months before surgery were at nearly double the risk of postoperative death and at three times the chance of developing postoperative pneumonia[20]. It is crucial to perform a thorough preoperative assessment and optimization including detailed medical history, pulmonary function tests, and medications to reduce the risk of perioperative respiratory adverse events in surgical patients with asthma. To reduce morbidity and mortality among surgical patients, it is necessary to administer an adequate depth of anesthesia, use fewer histamine-releasing drugs during the intraoperative phase, and closely monitor the postoperative respiratory system[21].

The prevalence and severity of bronchial asthma are rising globally, making it a widespread condition. The incidence of perioperative bronchospasm in bronchial asthma patients undergoing routine surgery is around 2%, especially if routine medication is continued. Surgical patients with bronchial asthma who underwent surgery poses a great challenge to the anesthetist. Hence, in order to reduce the perioperative respiratory adverse events, it is essential to select the best collective interventions. The significance of this guideline is to provide a proper preoperative evaluation, risk stratification, and optimization using a compilation of both pharmacological and non-pharmacological interventions, as well as intense intraoperative and postoperative adverse management.

The objectives of the present study was to develop the evidence-based practice guideline for perioperative management of bronchial asthma patients in a low-resource setting.

2. METHODS AND MATERIALS

The review was reported according to the Reporting Items for Practice Guidelines in Health Care (RIGHT) protocol (FIG-1)

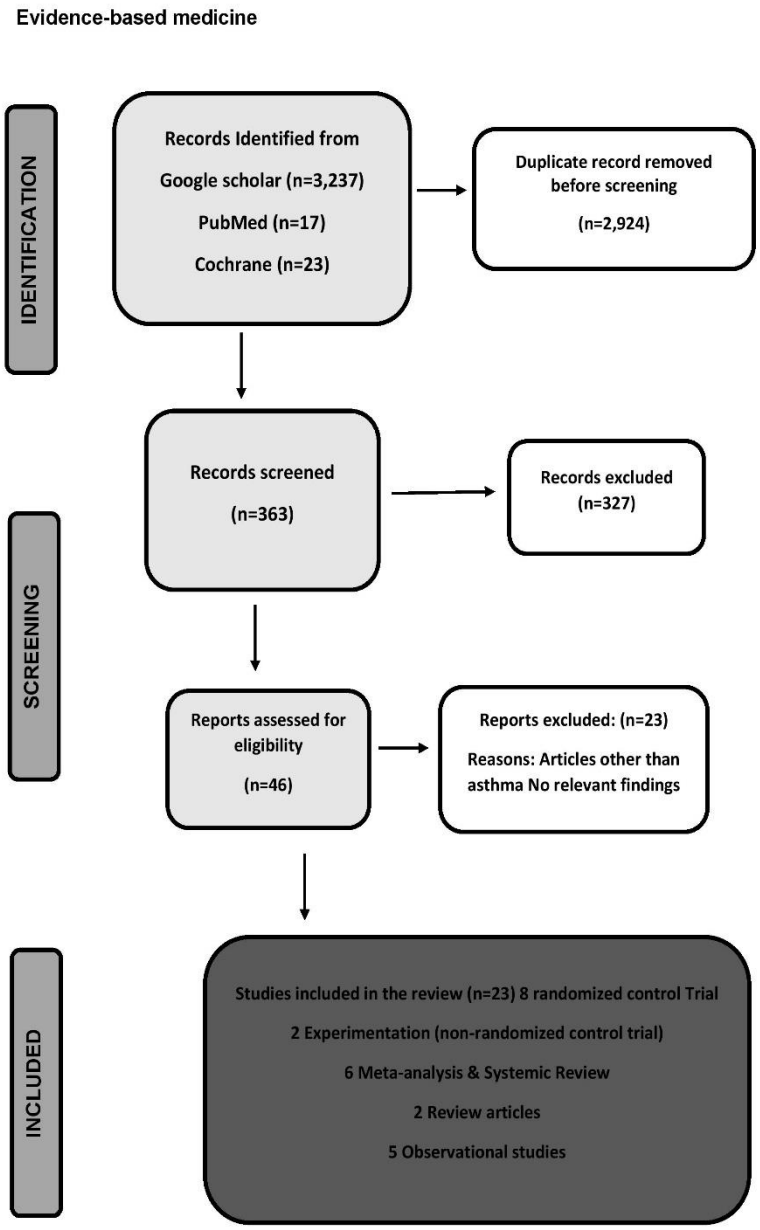

FIG-1. PRISMA flow diagram.

2.1. Search Strategy

A search of the literature was done from Cochrane Review, PubMed, and Google Scholar database key terms (Asthma OR Bronchial asthma) AND (Surgery OR Operation) AND (Anesthesia OR General Anesthesia OR Regional anesthesia) AND (Respiratory drugs OR Bronchodilators) AND (Perioperative adverse events OR complications) by using full sentences search for Google scholar.

2.2. Eligibility criteria

2.2.1. Inclusion

Meta-analysis and systematic review studies, interventional studies, cohort and cross-sectional studies published between 2008 and July, 2023 and other papers fulfilling the following criteria were included in the study; studies presented as original articles, comparative studies on airway intervention for a patient with bronchial asthma undergoing surgery, premedication for a patient with bronchial asthma undergoing elective and emergency surgery, incidence and management of perioperative respiratory adverse event in patient with bronchial asthma undergoing surgery, studies written in English language were included.

2.2.2. Exclusion

Studies without full articles or relevant outcomes were not selected to be included in the current review. All of the research articles that were identified from searches of the electronic databases were imported into the ENDNOTE software version X7 and duplicates were removed. Before findings had begun, full-length articles from the selected studies were read to confirm for fulfilling the inclusion criteria.

2.3. Data extraction

After extraction and filtering with a restricted period and exclusion criteria were done; 6 Systematic review and meta-analysis, 5 observational studies, 8 RCT, 2 non RCT, and 2 review articles were appraised for quality, and a conclusion was made based on their level of evidence and grades of recommendations (Table 1) that adapted from oxford center for evidence-based medicine. This evidence-based practice guideline will be revised within fifteen years.

4. RESULTS AND DISCUSSIONS

Results:

The search strategy identified a total of 3,237 articles from different electronic databases. 363 articles were selected for screening after duplicates were removed; finally, 23 studies containing 253 articles were included; 6 Systematic reviews and meta-analyses, 5 observational studies, 8 RCTs, 2 RCTs and 2 review articles were appraised for quality, and a conclusion was made based on their level of evidence. The summary of the studies included in the review shown in the (Supplementary Table 1).

Discussion:

Tissue damage and subsequent remodeling of the airway structure are caused by the chronic inflammatory process. Inhalation and exhalation of air are both obstructed by bronchospasm and mucus plugging. For the best possible outcome for the victims, asthmatic patients must be assessed, and optimized before, during, and after surgery.

4.1. Preoperative assessment and management

4.1.1. Preoperative assessment

In asthmatic patients undergoing major surgery, the incidence of perioperative bronchospasm is less than 2%, particularly if normal medication is continued. However, perioperative respiratory complications are more common in patients over 50 years having major surgery and in those with unstable illnesses. Patients with poorly managed bronchial asthma who now exhibit symptoms, a history of frequent exacerbations, or hospitalizations are at risk for developing perioperative respiratory issues such as bronchospasm, sputum retention, atelectasis, infection, and respiratory failure[14] **LOE-1a; GOR-A**.

To reduce perioperative respiratory adverse effects, elective surgery should be performed when the patient's asthma is under the best possible control. Preoperative evaluation should concentrate on and cover the activities of daily living, physical condition, presence of infectious symptoms, quantity and purulence of sputum, presence of allergies, triggers for attacks or exacerbations, use and efficacy of medications, prior surgical and anesthesia history, coexisting medical disorders, obesity, and sleep apnea syndrome[3,22] **LOE-1b; GOR-A**. The history of bronchial asthma, in particular, emergency department visits, hospitalizations, ICU stays, and the use of systemic corticosteroids, are independent risk factors for postoperative significant unfavorable outcomes in asthmatic patients and should be addressed by the anesthetist before surgery. Before the induction of general anesthesia, detailed preoperative examination should involve the monitoring of respiratory rate and auscultation of both lungs (for the presence or absence of adventitious lung sounds)[20,22] **LOE-2b; GOR-B** and L**OE-1a; GOR-A.** (Table 2).

4.1.2. Physical examination

In acute bronchospasm, breath sounds are muted or nonexistent when expiratory airflow is significantly reduced. The forced expiratory time (FET), which can be measured by hearing via the patient's trachea as they forcefully exhale, is a quick screening test for prolonged exhalation. A FET > 6s coincides with a significantly decreased FEV1/FVC ratio. Preoperative wheezing indicates a challenging perioperative course[23] **LOE-2b; GOR-B**.

4.1.3. Investigations

The investigations essential for the clinicians in determining the severity of bronchial asthma and in foretelling post-operative respiratory adverse effects are described below.

Pulmonary function testing / Spirometry: is used to assess whether airflow obstruction is at least partially reversible after the use of bronchodilators in patients of all ages.

Reversibility is indicated by an increase of at least 12% in FEV1 from baseline. Reversibility also exists in adults with an increase in FEV1 of more than 200 mL from baseline[24] **LOE-2a; GOR- B**

Electrocardiogram (ECG): Asthmatic patients may exhibit acute strain, right axis deviation, right bundle branch block, and right atrial or ventricular hypertrophy; therefore we should routinely get an ECG before and after the acute attack for comparison[14]**.**

Chest x-rays: it help exclude pneumonia or heart failure. Radiographic findings of bronchial asthma include bronchial thickening, bronchial hyperinflation, and enlarged lung markings, however, they are rarely useful in determining how to modify treatment[14] **LOE-1a; GOR-A**.

4.2. Optimizing Bronchial Asthma preoperatively

4.2.1. Preoperative Non-pharmacologic Optimization of Asthma

Most of the effective asthma control interventions focused either on patient education or a combination of a patient education program with measures to reduce exposure to allergens and indoor pollution[25] LOE-1a; GOR-A.

Air purification using a filter system has a positive impact on asthma control in children exposed to air pollution or second-hand smoke. Further studies employing personal monitoring devices for allergen, pollutant, and microbial exposure may clarify the importance of environmental interventions[9,26,27] **LOE-1b; GOR-A**.

Healthy diet and regular physical activity for their general health benefits, even if the evidence for one form of physical activity over another remains limited. Respiratory viruses trigger asthma exacerbations. For this reason, GINA logically recommends flu vaccination while acknowledging that it has not proved effective in asthma control[25,28] **LOE-1a; GOR-A.**

4.2.2. Preoperative pharmacologic optimization of asthma

For asthmatics to have surgery under general anesthesia, a step-by-step management strategy is advised[29]. One example of this is the treatment plan suggested by the Global Initiative for Asthma[30] **LOE-1b; GOR-A**.

Based on the severity of the disease and the patient's symptoms, a discrete therapy "step" is assigned to them. The number and variety of medications required to treat the patient rise in proportion to how severe the disease is. The preoperative preparation of bronchial asthma patient using this paradigm of increasing medication depending on symptom management is simple[14] **LOE-1b; GOR-A**.

The mainstays for stabilizing persistent bronchial asthma and lowering morbidity and mortality in surgical patients with bronchial asthma are inhaled corticosteroids like beclomethasone (40 mg twice daily)[31] **LOE-1b; GOR-A**. In addition, parenteral steroid medication like hydrocortisone (200 mg IV stat) and methylprednisolone (40–80 mg)[31] **LOE-1b; GOR-A**.

Patients who have been taking systemic corticosteroids for more than two weeks over the previous six months should be regarded as having an increased risk of adrenal suppression and require intraoperative supplementation with 1-2 mg/kg of hydrocortisone intravenously every eight hours and more on the day of surgery, followed by a return to previous dosage by gradually tapering off[4] **LOE-1b; GOR-A**.

Improvements in the preoperative lung functions and a reduction in the incidence of wheezing after endotracheal intubation can both be achieved with a combination of corticosteroids and a 2-adrenergic agonist (methylprednisolone 40 mg/day orally and salbutamol, respectively)**[30]** **LOE-1b; GOR-A**. For the best recovery of endobronchial cilia mucus clearance, smoker patients with uncontrolled bronchial asthma should stop smoking at least 6 to 8 weeks before surgery[32] **LOE-2b; GOR-B**.

4.3. Techniques of Anesthesia

4.3.1. Premedication

An ideal premedication that reduces anxiety and favors sympatholytic and antisialogue effects may increase breathing effort and perhaps prevent bronchospasm during induction.

4.3.1.1. Midazolam: To treat anxiety and anxiety-induced bronchospasm, giving anxious patients 0.5 mg/kg of midazolam is both safe and effective[4] **LOE-1a; GOR-A.**

4.3.1.2. IV Lidocaine: An IV lidocaine dose of 1.5–2 mg/kg given 90 seconds before laryngoscopy successfully suppresses the cough reflex and reduces increases in HR and MAP, according to a prospective randomized double-blind research[33] **LOE-1b; GOR-A.**

4.3.1.3. Opioids: For people with asthma, opioids are not advised. However, combining low-dose ketamine (0.15 mg/kg IV) with low-dose fentanyl (2 mcg/kg IV) avoids fentanyl-induced liver damage and successfully provides analgesia [34,35] **LOE-2a; GOR-B and LOE-1a; GOR-A** respectively. The preoperative category and optimization of surgical bronchial asthma patients were described by (FIG-2).

4.3.1.4. Anticholinergic: Antimuscarinics such as glycopyrrolate and atropine may decrease secretions and provide additional Broncho dilation if given in sufficient time before induction[27] **LOE-1a; GOR-A**.

4.3.2. Regional Anesthesia

Although local anesthetics theoretically raise bronchial smooth muscle tone by removing sympathetic tone, spinal and epidural anesthetics do not worsen bronchospasm in clinical practice. Thus, central neuraxial blocks can be used safely in a clinical situation with high propensity of bronchospasm[4] **LOE-2b; GOR-B**.

4.3.3. General Anesthesia

4.3.3.1. Induction and intraoperative management

The overriding goal in anesthetizing an asthmatic patient is to avoid bronchospasm and reduce the response to tracheal intubation. Severe bronchospasm may cause fatal or near-fatal events such as irreversible brain damage due to the inability to ventilate. The patient must be at a deep level of anesthesia before instrumenting the airway, as tracheal intubation during light levels of anesthesia can precipitate bronchospasm. Bronchial stimulation with rigid bronchoscopes or flexible intubation scopes, inhaling cold, dry gases, endobronchial suctioning, and airway stimulation with endotracheal intubation are common causes of intraoperative bronchospasm. If not necessary, all of these should be avoided in patients who are at risk for bronchospasm[14,22] **LOE-1a and LOE-1b; GOR-A** respectively.

Choice of induction agents for General Anesthesia

Propofol: Due to its capability to reduce the bronchospastic reaction to intubation in both asthmatics and non-asthmatics, propofol is the preferred induction drug in hemodynamically stable patients**[33]** **LOE-1b; GOR-A**.

Ketamine: is a good induction drug for bronchial asthmatics with hemodynamic instability, according to a comprehensive review, because it can directly relax smooth muscles and dilate the airways without lowering blood pressure or systemic vascular resistance [34] **LOE-1a; LOE-A**.

Inhalational Induction: Volatile anesthetics, in particular halothane, isoflurane, and sevoflurane, are ideal options for general anesthesia as they reduce airway reflexes and cause immediate relaxation of the smooth muscles of the bronchi[14] **LOE-2a; GOR-B**.

Desflurane should be avoided in bronchial asthmatics due to its irritating effects on the respiratory system and increased airway resistance[36] **LOE-1b; LOE-A**.

Neuromuscular Blocking Drugs

Neuromuscular blocking medications are typically the drugs that induce allergic responses the most frequently in the operating room[37,38] **LOE-1c; GOR-B**.

Suxamethonium chloride provides a considerable benefit for asthmatics who require a quick sequence induction in situations with limited resources without major morbidity and mortality, even though it can emit modest quantities of histamine.

According to a systematic study, rocuronium, vecuronium, and cis-atracurium are all safe for use in the induction and maintenance of asthma in asthmatics, whereas pancuronium, which only slightly increases histamine levels, has been used safely in patients with bronchial asthma with little morbidity[14] **LOE-1a**; **GOR-A**.

It should always be possible to get warm, humidified gases. If sufficient anesthesia is guaranteed, either the quick sequence induction or the normal induction should be carried out as recommended; succinylcholine is not contraindicated for the rapid sequence induction[3] (**LOE-1a; GOR-A**.

The type of surgery, the patient's condition, and other clinical factors are taken into consideration when deciding whether to intubate the trachea, administer anesthesia via a mask, or utilize a laryngeal mask airway (LMA). Tracheal intubation generates reversible increases in airway resistance, which are not seen when LMA is inserted[39] **LOE-1a**; **GOR-A.**

4.3.3.2. Intraoperative bronchospasm managements

Bronchospasm can cause breathing problems, air-trapping, dynamic hyperinflation, and a mismatch between ventilation and perfusion (V/Q), all of which can get progressively worse with time. Wheezing, coughing, and/or a greater effort required to breathe are bronchospasm signs and symptoms.

A "shark fin"-like capnography waveform, which symbolizes bronchoconstriction, is produced by bronchospasm

It is frequently advised to increase the depth of general anesthetic and hand ventilation to alleviate bronchospasm Followed by Strong bronchodilators and other medications as below;[40]**LOE-2b; GOR-B**.

The successful treatment of intraoperative bronchospasm requires a multimodal approach. Some of very effective methods to treat bronchospasm are Inhaled beta-2 agonists like albuterol and salbutamol[14,40] **LOE-1b; GOR-A**, intravenous dexmedetomidine[41] **LOE-1b; GOR-A,** Lidocaine[33] **LOE-1b; GOR-A**, magnesium[42] **LOE-1a; GOR-A**, ketamine[34] **LOE-1b; GOR-A,** steroids**[43] LOE-1b; GOR-A, inhaled anticholinergic** (ipratropium)[44,45] **LOE-1b; GOR-A** and inhalational sevoflurane[46] **LOE-2b; GOR-B** are available are currently available.

5. POST-OPERATIVE MANAGEMENT

The postoperative care of the bronchial asthma patients is often determined by the intraoperative course. Asthmatics may be safely discharged to the appropriate inpatient unit without further intervention if the surgery went smoothly and pain, nausea, and respiratory status were well-controlled. However, in the eve0nt of significant intraoperative complications with severe bronchospasm, extra precautions must be taken to ensure patient safety during the postoperative period. Early respiratory rehabilitation makes it feasible to limit the amount of sputum produced postoperatively, recover, and maintain ventilator gas exchange, preventing problems and allowing for an early hospital departure[4,14] **LOE-1c; GOR-B**.

Postoperative ventilation should be considered, allowing time for further medical management, recovery of airway function, and metabolism of neuromuscular blockers without the need for reversal agents

A group of medical professionals—doctors, nurses, and physiotherapists should do respiratory rehabilitation, sometimes assisted by the patient's family. Re-administering beta-agonists as necessary for persistent pain are advised before emergence and during the surgical recovery period. So, prescribe Salbutamol regularly, Reviewing the dose and route of administration of steroids daily and Avoiding NSAID in poorly controlled asthmatics is paramount during the post-operative period[14] **LOE-1b; GOR-A.** We developed evidence-based practice guideline for the perioperative management of bronchial asthma patients (FIG-3).

Conclusion: As the prevalence of asthma is increasing worldwide, the need for surgery is also increasing. Although the incidence of severe perioperative bronchospasm is relatively low in patients with bronchial asthma undergoing anesthesia, when it does occur it can be life-threatening. The keys to an uncomplicated perioperative course are assiduous attention to detail in preoperative assessment, proper optimization, and maintenance of anesthesia with optimum anti-inflammatory and bronchodilator regimen through the perioperative period. Early identification, prevention, and management of triggers are recommended. To avoid the inflammation and bronchoconstriction linked to endotracheal intubation in many asthmatic patients, systemic corticosteroids and bronchodilators should be used in treatment. Preoperative optimization with non-pharmacological measures like obtunding exposure to allergens and indoor pollution, environmental intervention like air purification, as well as a healthy diet and exercise poses super outcomes when supported by pharmacological interventions. Safe medications used as premedication before induction include low-dose ketamine (0.15 mg/kg IV, midazolam 0.5 mg/kg), intravenous lidocaine (1-1.5 mg/kg), coupled with salbutamol, and standard dose of anti-muscarinic. For asthmatic surgical patients, the best induction and maintenance drugs are propofol, ketamine, halothane, isoflurane, and sevoflurane. Additionally, succinylcholine and pancuronium, which produce

modest levels of histamine and have been used successfully in asthmatics with no morbidity, are to be avoided as much as possible. Vecuronium is safely used for inducing and maintaining general anesthesia in in patients with bronchial asthma. Atracurium and mivacurium should be avoided. Despite it being debatable, the majority of literature agrees that deep intubation and extubation are necessary. The postoperative course largely determines how the patient will be managed. If the procedure went smoothly and the patient's pain, nausea, and respiratory condition were all under control, asthmatics could be safely discharged to their homes or the appropriate inpatient unit without further assistance. However, if there were significant intraoperative complications, such as severe bronchospasm, extra precautions were needed to ensure patient safety during the recovery period.

Recommendations

We recommend that, perioperative management of patients with bronchial asthma should aimed at proper assessment, preoperative optimization with non-pharmacological measures like obtunding exposure to allergens and indoor pollution, environmental intervention like air purification, as well as healthy diet and exercise, which poses super outcomes when supported by pharmacological interventions. Low-dose IV ketamine, midazolam, IV lidocaine or combined with salbutamol are safe to be used as premedication before induction. Propofol ketamine, halothane, isoflurane, sevoflurane, and vecuronium facilitate smooth induction and maintenance for bronchial asthmatic surgical patients respectively. Summary non-pharmacological and pharmacological management modalities were presented with the grades of recommendations and levels of evidence (Table 3).

Abbreviations: ABG - Arterial Blood Gas. ED- emergency department. ICU- intensive care unit. MDI: metered-dose inhaler. PEEP: positive end-expiratory pressure. PPLAT: plateau pressure. RCT: randomized controlled trial. ICS: Inhaled Corticosteroids. SABA: Short-Acting Beta Agonist. LABA: Long-Acting Beta 2 Agonist. LAMA: Long-Acting Muscarinic Antagonist

Data availability: Data are available by correspondence author address upon reasonable request.

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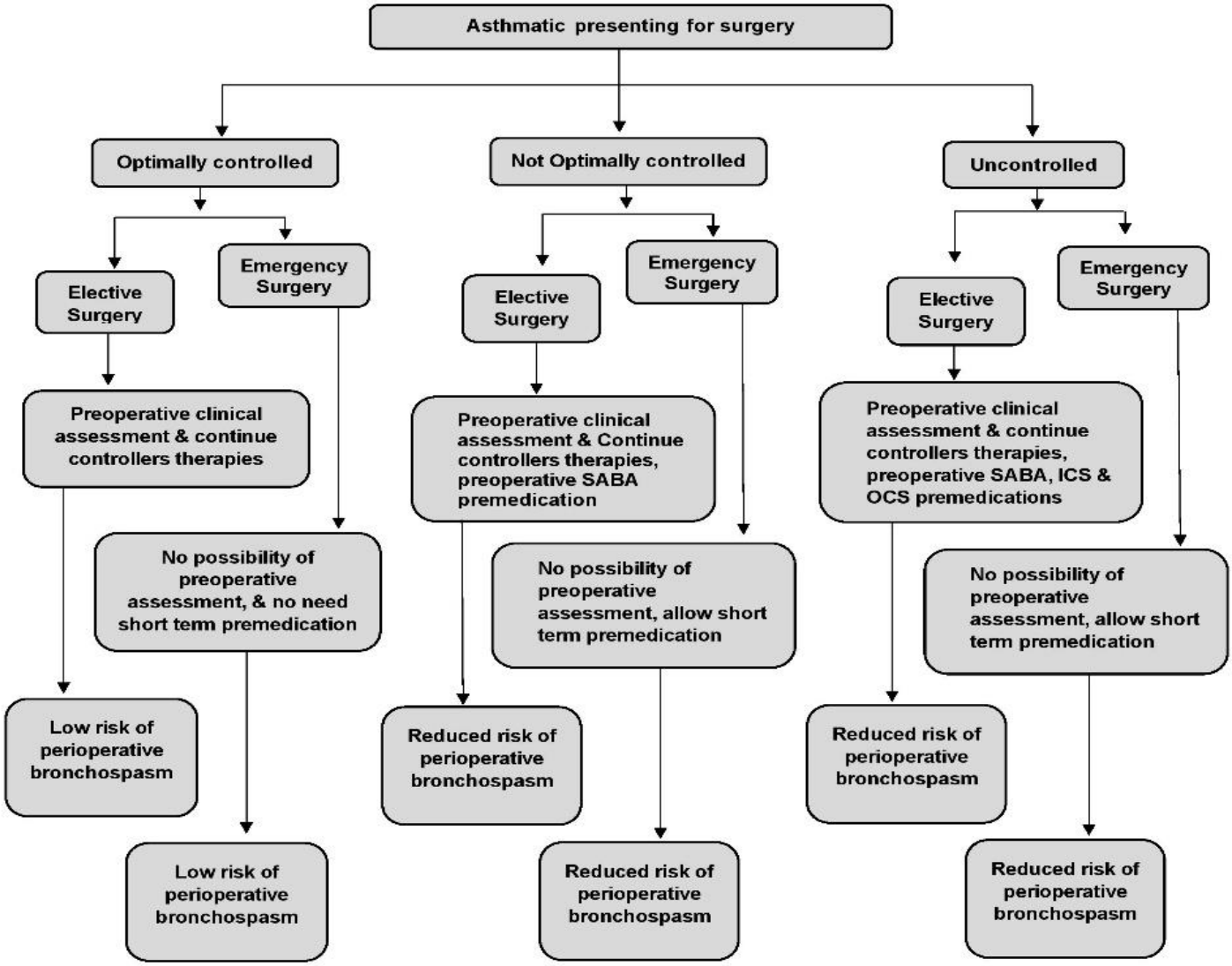

FIG-2. Preoperative category and optimization of surgical bronchial asthma patients.

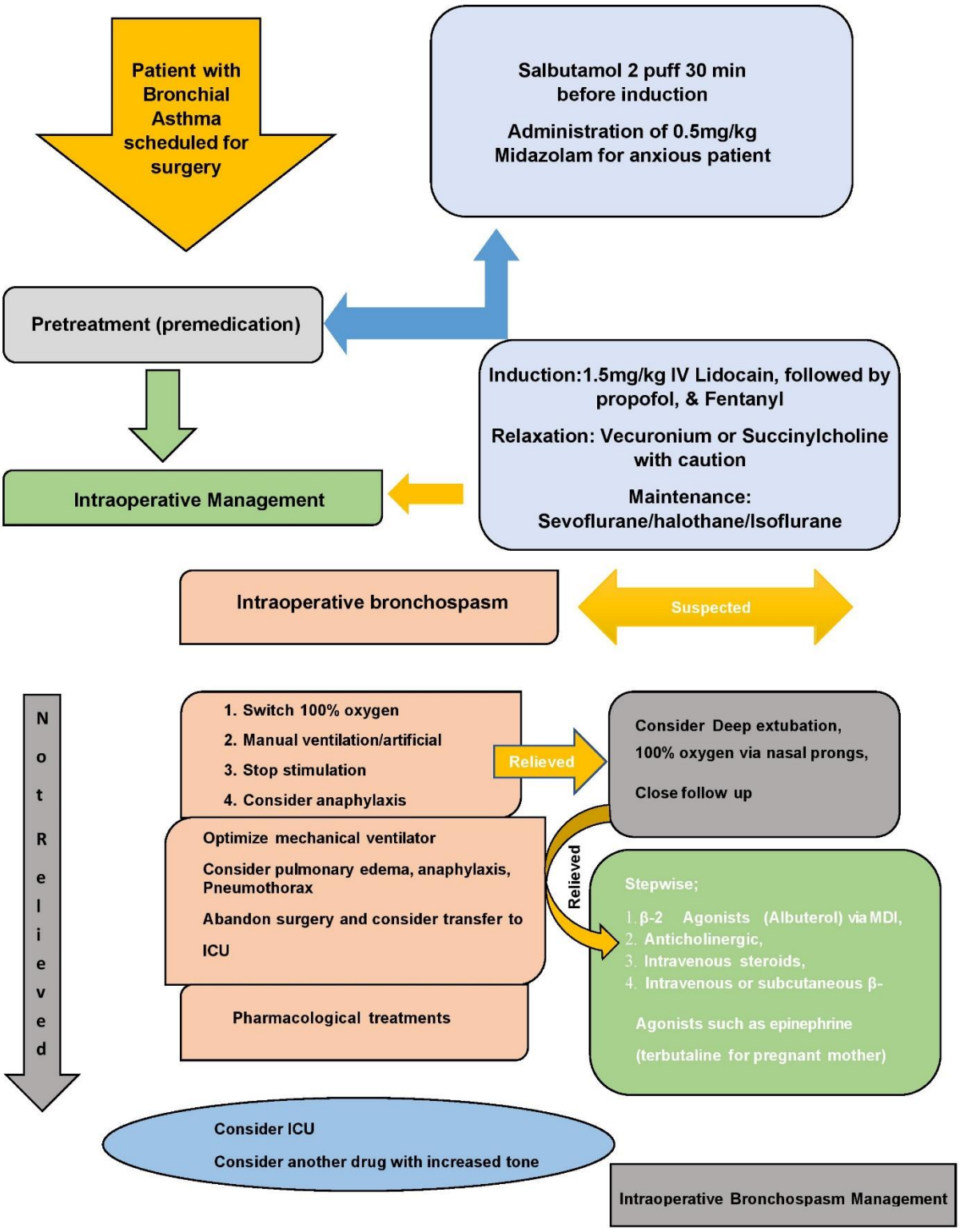

FIG-3. Evidence based practice guideline for the perioperative management of bronchial asthma patients.

Level of evidence	Grading criteria	Grades of recommendation
1a	Systematic reviews of RCTs including meta-analysis	A
1b	Individual RCT with a narrow confidence interval	A
1c	All or no randomized controlled trials	B
2a	A systematic review of cohort study	B
2b	Individual cohorts including low quality RCT	B
2c	Outcome research study	C
3a	Systematic review of case-control studies	C
3b	Individual case-control study	C
4	Case series, poor quality cohort, and case-control studies	C
5	Expert opinion without an explicit critical appraisal, or based on physiology, bench research, or “first principles”	D

Table 1. Levels of evidence and Grades of recommendation.

Optimally controlled asthma	Not optimally controlled asthma	Uncontrolled asthma
Symptoms <- 2days/week	Symptoms >2days/week	Symptoms throughout the day
SABA use <_2times/week	SABA use >2times/week	SABA is used several times/per day
Not interfered with normal activity	Some limitations with normal activity	extreme limitation with normal activity
Exacerbation requiring systemic CS <_1/year	Exacerbation requiring systemic CS 2-3x/year	Exacerbation requiring systemic CS >3x/year

Table 2. Preoperative asthmatic severity classification.

Classes	**Agents**	**LOE**	GOR
Preoperative non-pharmacological optimization	Obtunding exposure to allergens and indoor pollution	La	A
	Environmental interventions like air purification	1b	A
	Healthy diet and exercise	1a	A
	Smoking cessation	2b	B
Preoperative pharmacological optimization	Inhaled corticosteroids	1b	A
	Methylprednisolone	1b	A
	Hydrocortisone	1b	A
	Salbutamol	1b	A
Premedication	Midazolam	1a	A
	IV lidocaine,	1b	A
	Ketamine	1b	A
	Fentanyl	1b	A
	Salbutamol	1b	A
	Atropine, glycophylorate	1a	A
Induction agents (IV)	Propofol, ketamine	1b	A
VAAs	Sevoflurane, isoflurane, halothane	2a	B
Muscle relaxants	Suxamethonium, vecronium, pancronium	1a	A
Anti-cholinestrase	Neostigmine	1a	A
Others	IV dexmethomidine	1b	A
	Lidocaine	1b	A
	Mgso4	1a	A
	Inhaled Ipratropium	1a	A

Table 3. Summary of perioperative aspects of bronchial asthma managements with its grade of recommendations and Levels of Evidence.

Supplementary Table 1.

S.No	Author/ Year	Study	Sample size and Design	Findings of the studies	LOE
1	SEBAS ET AL 2021	Perioperative management of patients with asthma during elective surgery: A systematic review	SR and MA, 34 Articles	This review suggests Low-dose IV ketamine, midazolam, IV lidocaine, or combined with salbutamol are recommended to be used as premedication before induction. Propofol, ketamine, halothane, isoflurane, and sevoflurane are the best induction agents and maintenance for asthmatic surgical patients respectively. Among the muscle relaxants, vecuronium is safe for use in asthmatics. In addition, Succinylcholine and pancuronium which releases low levels of histamine has been used safely in asthmatics with little morbidity.	1A
2	Lin et al 2016	Postoperative Adverse Outcomes in Patients With Asthma	Cohort, 48,218	asthma significantly increased postoperative pneumonia, sepsis, urinary tract infection, and subsequent mortality, particularly for asthmatic patients with preoperative asthma-related emergency care, hospitalizations, ICU admissions, and use of systemic corticosteroids	2B
3	Tarek Shaban a et al 2019	Does combine inhaled salbutamol with intravenous corticosteroid prevent intubation-provoked bronchoconstriction??	RCT, 45	Combining less significantly in resulted in methylprednisolone compared bronchoconstriction provoked intubation with combined salbutamol and alone salbutamol to hydrocortisone	1B
4	S.M. BURB URAN ET AL 2014	Effects of inhalational anesthetics in experimental allergic asthma	RCT	Accordingly, our findings suggest that sevoflurane may be a suitable anesthetic agent for asthmatics, although further clinical studies are required to clarify this issue.	1B

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5	Numata et al. 2018	Risk factors of postoperative pulmonary complications in patients with asthma and COPD	Retrospective Cross sectional	History of smoking or severe asthma is a risk factor of PPC in patients with asthma, and age, upper abdominal surgery, or long operation time is a risk factor of PPC in patients with COPD. Adequate inhaled corticosteroid treatment in patients with eosinophilic asthma and introducing treatment for COPD in patients with COPD could reduce PPCs	2B
6	Erdogn et al. 2020	Is the Perioperative Period No Longer a Problem for Adult Asthmatics under Control?	Prospective cross-sectional study	Controlled asthma under treatment steps 1-2-3 does not cause any serious postoperative pulmonary complications (PPCs). Therefore, achieving an optimal control level of asthma during the preoperative period must be considered the “gold standard” to reduce the risk of PPCs in asthmatic patients	2B
7	Z.Shan Et al. 2013	Intravenous and nebulized magnesium sulfate for treating acute asthma in adults and children: A systematic review and meta-analysis	SR and MA of RCT	The use of intravenous magnesium sulfate, in addition to b2-agonists and systemic steroids, in the treatment of acute asthma appears to produce benefits concerning improving pulmonary function reducing the number of hospital admissions for children, and only improving pulmonary function for adults. However, the use of nebulized magnesium sulfate just appears to produce benefits for adults	1A
8	V. Nyakatri et al 2011	Respiratory resistance during anesthesia with isoflurane, sevoflurane, and desflurane	RCT, 71	In healthy adults, neither sevoflurane nor isoflurane produced bronchodilation at 1 and 1.5 MAC. Desflurane did not affect respiratory resistance at 1 MAC, but at 1.5 MAC caused a significant increase in both total and airway resistance with a return to near baseline values after discontinuation of the agent.	1B

9	Shweta Goyal et al 2013	Ketamine in status asthmaticus: A review	244, review	In various studies, ketamine is a potential bronchodilator in severe asthma. However, a large prospective clinical trial is warranted before laying down any definitive recommendations on its use in status asthmaticus.	1B
10	Murtaza Ali Gowa et al 2016	Response to nebulized salbutamol versus combination with ipratropium bromide in children with acute severe asthma	200, RCT	The combination of nebulized salbutamol along with ipratropium bromide in the treatment of acute asthma exacerbation was not superior to salbutamol alone	1B
11	KEENEY et al 2014	Dexamethasone for Acute Asthma Exacerbations in Children: A Meta- analysis	SR, MA of 6 RCT	Practitioners should consider single or 2-dose regimens of dexamethasone as a viable alternative to a 5-day course of prednisone/prednisolone	1A
12	Eugene R. Bleecker et al 2020	Systematic Literature Review of Systemic Corticosteroid Use for Asthma Management	139 0bservational studies	Overall, this review demonstrates that OCS and SCS, including long-term OCS, continue to be commonly used and overused for the management of asthma across the disease spectrum particularly for severe asthma	2A

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13	Ramgolam et al. 2018	Inhalational versus Intravenous Induction of Anesthesia in Children with a High Risk of Perioperative Respiratory Adverse Events	300, RCT	The results of this trial should not be interpreted as supporting the exclusive use of IV induction of anesthesia. While the results favor IV induction in children at an increased risk of perioperative respiratory adverse events, there are patient groups who will still benefit from an inhalational induction, e.g., those with needle phobia or with a history of difficult IV access	1B
14	D. Schutte 2013	Sevoflurane therapy for life-threatening asthma in children	7, retrospective case series	Sevoflurane inhalation corrects high levels of PCO2 and provides clinical improvement in mechanically ventilated children with life-threatening asthma who fail to respond to conventional treatment.	2C
15	Daniel R. Morales Et al 2014	Adverse Respiratory Effect of Acute b - Blocker Exposure in Asthma	SR and MA of RCTs	Selective b-blockers are better tolerated but not completely risk-free. The risk from acute exposure may be mitigated using the smallest dose possible and b- blockers with greater b1-selectivity. Beta Blocker- induced bronchospasm responded partially to b2- agonists in the doses given with response blunted more by nonselective b-blockers than selective b-blockers. The use of b-blockers in asthma could be based upon a risk assessment on an individual patient basis.	1A
16	Rebecca Normansel et al 2016	Different oral corticosteroid regimens for acute asthma	Review of 18 RCT studies	Overall, we found no convincing evidence of differences in outcomes between a higher dose or longer course and a lower dose or shorter course of prednisolone or dexamethasone, or between prednisolone and dexamethasone.	1B
17	P. Roglian i et al. 2013	The influence of propofol, remifentanil, and lidocaine on the tone of human bronchial smooth muscle	Experimental, 13	Propofol and remifentanil may be used safely for bronchoscopy, although remifentanil should be associated with propofol or lidocaine to prevent the potential opioid-mediated bronchospasm	1B

18	Cooper DD ET AL 2015	Should Children With Acute Asthma Exacerbation Receive Inhaled Anticholinergic?	SR of 20 Trials	This systematic review demonstrates that inhaled anticholinergics (specifically, ipratropium bromide), along with shortacting β-agonists (specifically, albuterol) reduce the number of hospital admissions for pediatric patients with acute moderate to severe asthma exacerbations. However, using the combined inhaled treatments does not seem to reduce the risk of a recurrent asthma attack	1A
19	Colin Powell et al 2013	Magnesium sulfate in acute severe asthma in children (MAGNETIC): a randomized, placebo-controlled trial	RCT, 508	Overall, nebulized isotonic MgSO4, given as an adjuvant to standard treatment, did not show a clinically significant improvement in mean ASS in children with acute severe asthma. However, the greatest clinical response was seen in children with more severe attacks (SaO2	1B
20	R. Aksu et al.2009	Comparison of the Effects of Dexmedetomidine Versus Fentanyl on Airway Reflexes and Hemodynamic Responses to Tracheal Extubation During Rhinoplasty	RCT, 40	The findings in the present study suggest that dexmedetomidine 0.5 μg/kg IV, administered before extubation, was more effective in attenuating airway reflex responses to tracheal extubation and maintaining hemodynamic stability without prolonging recovery compared with fentanyl 1 μg/kg IV in these patients undergoing rhinoplasty	1B
21	Mikami et al. (2017)	Dexmedetomidine's inhibitory effects on acetylcholinerelease from cholinergic nerves in guinea pig trachea: a Mechanism that accounts for its clinical benefit during airway irritation	Experim ental,	The α2 adrenoceptor agonist dexmedetomidine reduced cholinergic EFS-induced contractions and acetylcholine release consistent with the presence of inhibitory α2 adrenoceptors on the prejunctional side of the postganglionic cholinergic nerve-smooth muscle junction.	1B

22	Ahmed Mohamed et al. 2021	A Study of Electrocardiographic Changes in Asthmatic Patients Attending Kirkuk General Hospital	Prospective cohort	Patients with acute asthma can manifest various ECG changes and these changes return to normal after medical therapy, usually within 10 days.	2B
23	Matthieu Schuers et al 2019	Impact of non-drug therapies on asthma control: A systematic review of the literature	SLR of 82 studies	Twenty-six interventions were effective in asthma control. Simultaneously combining several action plans, each focusing on different aspects of asthma management, seems most likely to be effective.	1A

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