

Perioperative Anaphylaxis

Diagnosis, Evaluation, and Management



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KEYWORDS

- Anaphylaxis • Perioperative • Anesthesia • Asthma • Tryptase • NMBAs
- Antibiotics

KEY POINTS

- Perioperative anaphylaxis is becoming more common as the use of anesthesia and antibiotics increases. It can have fatal outcomes if not identified and treated quickly.
- Evaluation of a patient with a history of perioperative anaphylaxis requires a detailed medical history, a review of the anesthetic record, and collaboration between the anesthesiologist and the allergist.
- Testing to identify the implicated agents by skin testing, intracutaneous testing, and/or specific immunoglobulin E ideally should be performed 4 to 6 weeks after the event to ensure accuracy of the results.
- All asthmatic patients or patients with a remote history of asthma should ideally undergo a preoperative assessment of their lung function by spirometry and, if available, an exhaled nitric oxide test to assess their level of control.

INTRODUCTION

Anaphylaxis is defined as a serious, life-threatening generalized or systemic hypersensitivity reaction that is rapid in onset and may cause death.^{1,2} Perioperative anaphylaxis can occur during surgery or postoperatively and present as cardiovascular collapse, airway obstruction, or arrest with or without skin manifestations.³ Anaphylaxis has been classified into 4 grades depending on the severity of symptoms reported.⁴ Grade I includes cutaneous signs, grade II includes non-life-threatening symptoms, grade III includes life-threatening symptoms such as arrhythmias and bronchospasm, and

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grade IV includes cardiac and respiratory distress.⁴ Although its incidence is difficult to establish,⁵ it is estimated to occur in 1 in 3500 to 1 in 20,000 surgeries, with a mortality ranging from 3% to 9%.^{4,6,7} Worldwide, it accounts for 9% to 19% of all surgical complications and 5% to 7% of all deaths during anesthesia.⁶

Anaphylaxis occurs as the result of a stimulus causing the release of bioactive mediators from mast cells and basophils in 2 or more organ systems of the body.^{4,5} The release of mediators leads to extensive capillary permeability, vasodilation, bronchoconstriction, and hypotension associated with anaphylaxis.⁴ When it occurs in relation to a drug, it is usually both unexpected and dose independent.^{8,9} The mechanism may be immunoglobulin (Ig) E or non-IgE mediated, the latter including immune complex formation leading to activation of complement, or it can be related to direct histamine release.^{1,6,7,10} Although most systemic anaphylaxis reactions are immediate, delayed reactions can occur.⁴

Perioperative anaphylaxis is becoming more common, most likely because of the increased frequency of using anesthesia and the increased complexity of anesthesia protocols.^{3,7} Thus, it requires careful evaluation by the allergist in conjunction with the anesthesiologist to identify the cause so that safe anesthetic regimens can be recommended in the future.^{3,4,6} This article presents 2 cases of perioperative anaphylaxis followed by a review of the approach for evaluating and managing patients who experience perioperative anaphylaxis and a discussion regarding the most commonly implicated agents.

Case 1

Patient 1 is a 72-year-old caucasian woman with a medical history of kidney stones, hypertension, diabetes mellitus, and hypothyroidism who presented after anaphylaxis during a cystoscopy. She had no prior history of asthma. She had undergone 3 lithotripsies and a knee surgery in the past without issues. Pertinent medications included atenolol 25 mg and diclofenac 75 mg once a day. On the day of her surgical procedure, she was given ciprofloxacin perioperatively, propofol, lidocaine, glycopyrrolate, and the anesthetic gases desflurane and sevoflurane intraoperatively. She also received Oxilan, a radiographic contrast media (RCM), during the procedure. In the recovery room, approximately 60 minutes after the conclusion of the procedure, the patient complained of chest tightness and then developed diffuse urticaria and hypotension. She was immediately treated with intramuscular (IM) epinephrine 0.03 mg 1:1000 and intravenous (IV) diphenhydramine 50 mg; a hand-held nebulizer treatment with albuterol and methylprednisolone 60 mg IV were also administered. Her hives rapidly resolved and her blood pressure normalized. Subsequent outpatient skin testing to lidocaine, propofol, glycopyrrolate, and ciprofloxacin was negative. This testing was followed by a challenge to each, which was negative as well. Based on her history it was presumed that the reaction was most likely secondary to the RCM. Recommendations were made to use low-osmolality contrast material and pretreat with corticosteroids and diphenhydramine according to published guidelines before any future procedures requiring RCM.^{3,11}

Case 2

Patient 2 is a 24-year-old woman with a remote history of asthma not requiring treatment, allergic rhinitis, egg allergy, and atopic dermatitis who presented for further evaluation after 2 episodes of perioperative anaphylaxis. While undergoing anesthetic induction for the initial jaw surgery she developed hypotension, wheezing, and hypoxia leading to cardiopulmonary arrest. Surgery was immediately stopped and she was treated by anesthesia with epinephrine 0.3 mg 1:1000 IM, IV fluids, and IV

corticosteroids. She was referred to an allergist and was subsequently tested to several medications that were administered perioperatively. She had positive intracutaneous skin testing to the neuromuscular blocking agents (NMBAs) vecuronium, succinylcholine, rocuronium, and cisatracurium. She was also skin test positive to penicillin, sulfamethoxazole, ciprofloxacin, and the first-generation cephalosporin cephalexin. These agents were all avoided during a second surgery; however, she again developed similar symptoms, including severe bronchospasm requiring epinephrine 0.3 mg 1:1000 IM, IV fluids, and corticosteroids. She was then referred to our clinic for further assessment. During her reevaluation, spirometry to assess asthma control revealed a forced expiratory volume in 1 second of 91% with 14% reversibility after bronchodilator and an exhaled nitric oxide level of 52 ppb. Serum tryptase, sedimentation rate, C-reactive protein, and thyroid-stimulating hormone were all normal. She was started on an inhaled corticosteroid, cetirizine 10 mg daily and a rescue short-acting beta-2 agonist, and an epinephrine injector was provided. Further review of the anesthetic record showed that before each surgery she was administered a β -blocker intraoperatively. It was thought that her uncontrolled asthma compounded with the use of a β -blocker resulted in respiratory arrest. Before her third surgery, after her asthma was deemed to be controlled, she was still empirically pretreated with prednisone and diphenhydramine to further mitigate the potential for any unforeseen complications. In addition, NMBAs and β -blockers were avoided. She was able to tolerate 2 subsequent surgeries successfully without complications.

EVALUATION

The manifestations of anaphylaxis during anesthesia can be different from anaphylaxis not associated with anesthesia, making the diagnosis of perioperative anaphylaxis more challenging.^{7,12} For example, symptoms such as malaise, pruritus, dizziness, and dyspnea can be difficult to ascertain in an unconscious patient.^{6,12} The most commonly reported objective features include pulselessness, ventilation difficulty, decreased end-tidal CO₂, and desaturation.¹² Other symptoms may include urticaria, flushing, skin rash, angioedema, nausea, vomiting, diarrhea, bronchospasm, rhinoconjunctivitis, and hypotension.^{6,8} Although tachycardia can occur, bradycardia occurs more often, which can obfuscate the diagnosis.^{3,6} The diagnosis may be even more difficult to determine in patients who are on preoperative β -blockers, which are frequently administered to reduce cardiovascular morbidity and mortality.^{6,13}

Recognition of perioperative anaphylaxis is complicated, because patients are often sedated and therefore unable to alert physicians of symptoms. In addition, the diagnosis can be hampered because skin manifestations can be hidden by surgical drapes, cardiac events associated with anaphylaxis can be mistaken for other causes of cardiovascular collapse, and multiple drugs are frequently administered at the same time or in rapid succession.^{3,6,12} Most of these reactions occur within minutes of administration of the suspected agent, but late-onset reactions can occur, depending on the agent and the timing of its administration.⁶

Treatment during the event should include cessation of the anesthetic or drug, rapid volume expansion, and prompt epinephrine administration.^{2-5,14} Antihistamines are useful to treat skin manifestations and beta-adrenergic agonists should be used to treat bronchospasm.⁶ Glucagon can be administered in patients on β -blockers or who have been administered a β -blocker perioperatively, to overcome epinephrine resistance.^{2,3} Corticosteroids can be used for controlling the progression of bronchospasm and to prevent late-phase anaphylaxis.^{4,6} The evaluation should begin with a thorough investigation of the anesthetic record regarding the details and timing of

the event and medication administration (Fig. 1).^{6,15} Medical history should include information regarding previous adverse drug reactions (Fig. 2).^{3,4} All patients with a history of anaphylaxis during the perioperative period should have their medication list carefully reviewed for drugs that may place them at increased risk for anaphylaxis before any future surgeries.

RISK FACTORS

There are multiple risk factors associated with perioperative anaphylaxis that must be considered (Fig. 3). These risk factors include atopy; a previous history of reactions to anesthetic agents or other medications or products used during the procedure; multiple surgeries; latex allergy; children with spina bifida who have had multiple surgical interventions; allergic reactions to foods such as avocado, kiwi, banana, pineapple, papaya, chestnut, buckwheat, or *Ficus benjamina* that may cross react with latex^{4,15,16}; systemic mastocytosis; and hereditary angioedema.⁶

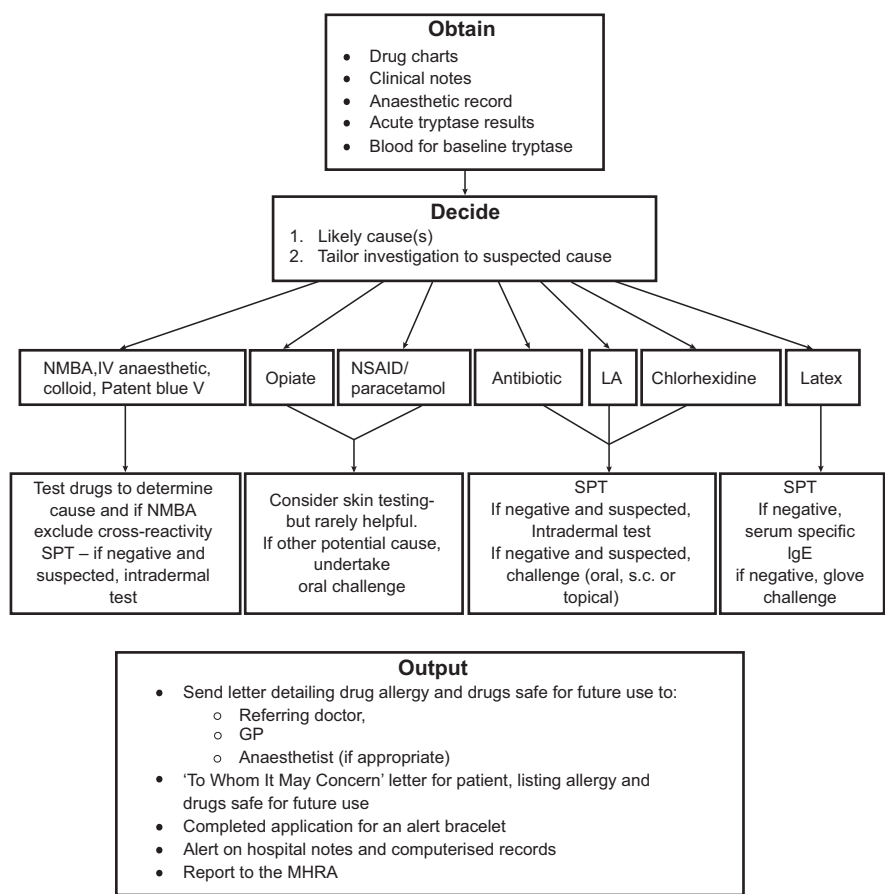


Fig. 1. Perioperative anaphylaxis evaluation. GP, general practitioner; NSAID, nonsteroidal antiinflammatory drug; s.c., subcutaneous; SPT, skin prick testing; LA, local anesthetics; MHRA, medicines and medical devices regulation. (From Ewan PW, Dugué P, Mirakian R, et al. BSACI guidelines for the investigation of suspected anaphylaxis during general anaesthesia. Clin Exp Allergy 2010;40(1):20; with permission.)

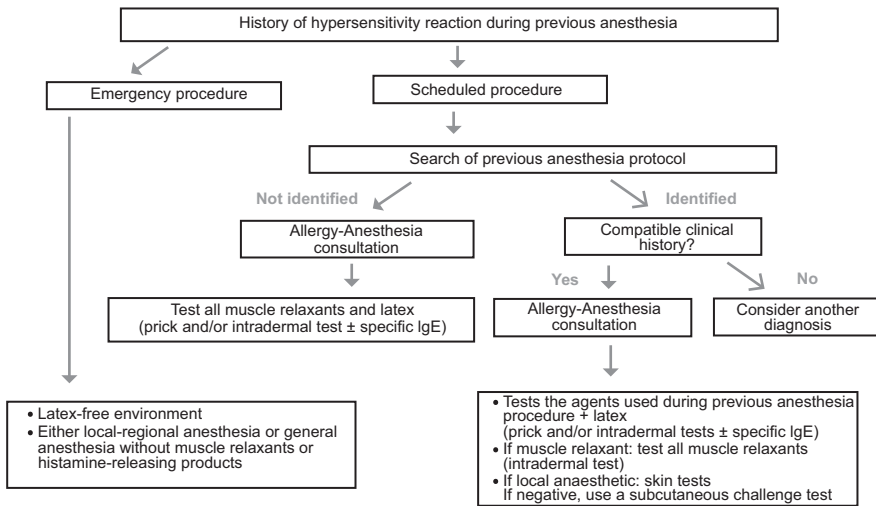


Fig. 2. Evaluation of a patient who has experienced a prior adverse reaction to anesthesia. (From Mertes PM, Malinovsky JM, Jouffroy L, et al. Working Group of the SFAR and SFA. Reducing the risk of anaphylaxis during anesthesia: 2011 updated guidelines for clinical practice. *J Investig Allergol Clin Immunol* 2011;21(6):450; with permission.)

Asthma, and especially uncontrolled asthma, is a known risk factor for all types of anaphylaxis because it is frequently a target organ.^{17,18} Although volatile anesthetics have been shown in some studies to have a bronchodilatory effect and have been used in treatment of status asthmaticus,¹⁹ bronchial hyperactivity and bronchospasm can occur at any point after administration of anesthesia during surgery.^{17,18} This risk is increased if the asthma is uncontrolled, as shown by a recent asthma attack,⁸ overuse of bronchodilators, or recent hospitalization for asthma.²⁰ Therefore, assessment of an asthma patient's level of control, which should include either spirometry or pulmonary function tests, is of paramount importance in the preoperative evaluation.^{18,20} Patients with uncontrolled disease should be placed on inhaled corticosteroids and, if needed, a beta-2 agonist, because these have been shown to decrease bronchial hyperactivity during anesthesia.^{4,6,18} With the exception of urgent or emergent indications, patients with uncontrolled asthma should have surgery postponed until optimal control is achieved. This important point is made in the case described earlier.

Patients with perioperative anaphylaxis should be queried for other rare systemic conditions that can predispose to anaphylaxis, such as hereditary angioedema^{21–23} and systemic mastocytosis.^{24,25} Atopic individuals may be at increased risk for more frequent and severe reactions.^{3,26} These reactions are more common in women than in men, in particular with latex and NMBAs.²⁶ Although it is unclear whether β -blockers increase the risk of anaphylaxis, they can make it more difficult to treat these reactions.^{3,4} Patients on this class of medication should be monitored closely. The above cases highlights the importance of these risk factors.

COMMONLY IMPLICATED AGENTS

Neuromuscular Blocking Agents

NMBAs are the most common cause of perioperative anaphylaxis, accounting for up to 60 to 70% of reported cases.^{3,4,26–30} Rocuronium and succinylcholine are the most commonly implicated agents.⁷ Anaphylaxis may occur either secondary to an

A

Risk Factor or Event Risk-Related agents

Spina bifida	Latex
Penicillin anaphylaxis	Cephalosporin, penicillin
Allergy to eggs/soybean emulsion	Propofol
Gelatin allergy	Plasma volume expanders
Sensitization to exotic fruits	Latex
Urticaria/angioedema	
Previous anaphylaxis related to general anesthesia	All agents
Previous unexplained reactions during general anesthesia	All agents
Multiple drug allergy syndrome	All agents
Penicillin allergy	Cephalosporin
Allergy	All agents
Atopy	All agents
Asthma	All agents
Previous exposure to a general anesthetic	NMBDs
Family history of general anesthesia anaphylaxis	All agents
Allergy to cosmetics	NMBDs



B

- History of a previous reaction to a contrast medium
- History of allergy
- Mastocytosis (especially if systemic)
- Contrast medium dose required
- History of cardiac or metabolic disease
- Injection route (intravenous vs intra-arterial) and rate of infusion of the medium
- Female gender
- Age
- Anxiety



Fig. 3. Risk factors for increased risk of anaphylaxis for general anesthetics (A) and radiocontrast (B). (From Liccardi G, Lobefalo G, Di Florio E, et al, Hospital Radiocontrast Media and Anesthetic-Induced Anaphylaxis Prevention Working Group. Strategies for the prevention of asthmatic, anaphylactic and anaphylactoid reactions during the administration of anesthetics and/or contrast media. J Investig Allergol Clin Immunol 2008;18:3; with permission.)

IgE-mediated mechanism or from direct histamine release from mast cells.^{3,6} Specific IgE sensitization is directed toward the tertiary or quaternary ammonium groups of these agents and is responsible for cross reactivity between NMBAs.^{3,4,6,26} This cross reactivity occurs most commonly between vecuronium and pancuronium.³ Other potential agents that cross react with NMBAs include choline, acetylcholine, morphine, neostigmine, and pentolium.³ Pholcodine, an over-the-counter antitussive agent available in other countries, has also been reported to cross react with NMBAs.^{31,32} Reactions are more common in women, and it is thought that cross reactivity of specific IgE with NMBAs can occur with the ammonium compound found in personal care products.^{3,26}

Latex

Latex was the second most common agent responsible for perioperative anaphylaxis but the incidence has significantly decreased because most hospitals and outpatient surgical facilities have adopted latex-free policies.^{4,6,26} Reactions tend to occur during the maintenance phase of anesthesia.⁶ Children with a history of multiple surgeries, including those with spina bifida, spinal cord trauma, and urogenital

malformations, were found to be of greatest risk for an IgE-mediated reaction to latex, with different epitopes of Hev b proteins being implicated.^{26,33,34} In addition, patients with a history of allergy to specific foods that cross react with latex were found to be at increased risk, possibly related to lipid transfer proteins.^{26,35} One case report describes a patient with latex sensitization and peach allergy who developed anaphylaxis during surgery, which highlights this important point.³⁶ Patients with a history of asthma and health care workers were also found to be at increased risk for latex anaphylaxis.^{6,26}

Antibiotics

Antibiotics are frequently implicated in perioperative anaphylaxis.^{3,27} These medications are commonly administered before and during surgery and reactions can be IgE or non-IgE mediated.³ The most commonly associated antibiotics include β -lactams and vancomycin.³ The highest cross reactivity exists with penicillins and first-generation cephalosporins; these reactions are becoming more common because of the increased use of perioperative antibiotic prophylaxis.^{3,27} Although IgE-mediated anaphylaxis to vancomycin has been reported, reactions to this drug are more commonly non-IgE mediated, caused by direct histamine release resulting in red man syndrome, which is related to the infusion rate, with higher rates increasing the likelihood of histamine release.^{3,6} IgE-mediated reactions to quinolones, rifampin, and bacitracin have also been reported.^{17,37–40} Guidelines recommend that infusion of antibiotics occur while the patient is awake in order to better assess any reaction that develops.⁴

Hypnotics

Several cases of anaphylaxis to barbiturates, in particular thiopental, have been reported.^{3,41,42} Specific IgE antibody reactions and direct histamine release have been implicated as mechanisms of action.^{3,43} These reactions are most common in women.^{3,44} Reactions to etomidate and ketamine are rare.^{26,30,45} Atopy has been suggested to be a predisposing factor for nonspecific histamine release after ketamine.²⁶

Propofol has been reported to cause IgE-mediated reactions with its 2 isopropyl groups acting as antigenic epitopes; however, most reactions are nonimmunologic secondary to direct histamine release.^{3,6} This effect may be greater in the presence of NMBAAs.³ Although it has been proposed that patients allergic to egg and soy have an increased risk of anaphylaxis to propofol, there is no evidence to support this theory.²⁷

Allergic reactions to IV diazepam are often caused by the propylene glycol solvent, which is sensitizing and can be found in medications, cosmetics, vaccines, and foods.^{26,46} An IgE-mediated reaction to its metabolite has been proposed to be responsible for its cross reactivity with other benzodiazepines.²⁶

Opioids

Anaphylaxis to narcotics in the perioperative period is rare and most commonly occurs through non-IgE-mediated nonspecific histamine release.^{3,6,8,26,47} Most of the reactions include flushing, urticaria, pruritus, and mild hypotension.^{3,8} Although fentanyl has not been shown to stimulate histamine release,^{3,6,26} there are reports of IgE-mediated anaphylaxis to both morphine and fentanyl.^{3,48–50} Reducing the rate of opioid administration limits the severity of these non-IgE-mediated reactions.³

Colloids

Colloids, or plasma volume expanders, include gelatin, albumin, hydroxyethyl starch (HES), and dextrans.^{26,51,52} They are responsible for approximately 4% of all

perioperative anaphylaxis cases.^{26,53} Reactions to these agents are most common in men and in patients with a history of multiple drug allergies. Dextran and HES reactions are rare, occurring in less than 1% of all reactions.^{3,54–56} Although specific IgG antibodies can be detected, their clinical significance is unknown.^{3,52,57–60} Specific IgE antibodies have been detected to gelatin.^{52,61} Gelatin is contained in many products, including foods, vaccines, pharmaceuticals, and cosmetics, and therefore exposure is common.^{26,62} Case reports have described systemic reactions to albumin but it is unclear whether the mechanism is IgE or non-IgE mediated.^{3,51,63}

Hemostatics

Intravenous protamine has been reported to cause anaphylactic reactions and IgG and IgE antibodies to protamine have been identified.^{3,64} Case reports have proposed that they cross react with fish.⁶⁵ Anaphylaxis to aprotinin and thrombin has been reported along with detection of specific IgG and IgE antibodies.^{66,67} Reactions to fibrin sealants have also been reported.⁶⁸

Chlorhexidine

Chlorhexidine is a widely used antiseptic with the potential to cause various reactions, including irritant or allergic contact dermatitis, urticaria, and anaphylaxis.^{6,8,69} Chlorhexidine is frequently used in the health care setting for its disinfectant properties but is also found in medical equipment, toothpaste, mouthwash, and household cleaning products.^{69,70} Chlorhexidine IgE-mediated sensitization may occur through cutaneous, percutaneous, mucosal, and parenteral exposure.^{69,70} It has been suggested that patients with a history of allergic contact dermatitis secondary to chlorhexidine may be at increased risk for anaphylaxis.²⁶ The incidence of reactions to chlorhexidine is thought to be underestimated.⁸

Blue Dyes

Blue dyes are commonly used intraoperatively for lymph node biopsy and sentinel lymph node dissection.^{71,72} Blue dyes have been reported to rarely cause anaphylactic reactions, with the estimated incidence being 1% to 2%, with severe reactions compromising only 0.2% to 1.1% of cases.^{7,71,72} Although cross-linkage of IgE antibodies and direct mast cell activation have been postulated,⁷² reactions are more likely to occur secondary to the blue dye acting as a hapten binding to an endogenous protein forming a circulating complex capable of eliciting IgE sensitization.⁷¹ It has been proposed that reactions secondary to blue dyes commonly develop as a result of their chemical similarity to isosulfan blue, a member of the triphenylmethane-based dye family commonly found in products such as cosmetics, soaps, antifungals, and paper industry materials.^{26,71}

Nonsteroidal Antiinflammatory Drugs

Nonsteroidal antiinflammatory drugs (NSAIDs) inhibit cyclooxygenase, leading to the overproduction of leukotrienes.^{8,26} These agents can produce bronchospasm, urticaria, and angioedema.⁸ The mechanism for NSAID-induced anaphylaxis is most commonly non-IgE mediated but IgE-mediated reactions have been reported.^{3,8,73} It has been reported that a prior reaction to a cyclooxygenase (COX) 1 inhibitor is a risk factor for subsequent reactions to a COX2 inhibitor.²⁶ However, this is inconclusive because patients who have experienced reactions to COX1 agents can often tolerate COX2 agents.²⁶ In one study, NSAIDs were the most common cause of anaphylaxis and were associated with a higher rate of repeat reactions.⁷⁴

Other Agents

Angiotensin-converting enzyme inhibitors have been associated with non-IgE-mediated anaphylaxis.⁷³ Reactions to local anesthetics are uncommon and, when confirmed, reactions are more commonly found with ester versus amide agents.^{3,75} One study found that 97% of skin tests to local anesthetics performed on patients with suspected local anesthetic allergy were negative.⁷⁶ Both immediate and delayed reactions have been reported to RCM, including anaphylaxis.^{77,78} Risk factors for an RCM reaction include previous reaction to RCM, a history of cardiac disease, asthma, chronic kidney disease, β -blocker use, food allergy, drug allergy, contact allergy, and therapy with the cytokine interleukin-2.²⁶ However, neither seafood allergy nor allergy to iodine are risk factors for an RCM reaction.²⁷

EVALUATION AND MANAGEMENT

Tryptase is a protease released from mast cells during immediate hypersensitivity reactions.⁶ An increased tryptase level of more than 25 $\mu\text{g/L}$ one to six hours after suspected anaphylaxis suggests mast cell activation and mediator release and supports the diagnosis.^{3,4,24} However, a normal tryptase level does not rule out anaphylaxis.^{3,6,24} A high tryptase level should be repeated a few days after the event to rule out other diseases associated with a persistently high tryptase level.^{4,6,24} Additional diagnostic testing based on the patient's past history and the medications they were exposed to perioperatively is often warranted in order to determine the cause of the acute increase in tryptase level.³ A plasma histamine level, if checked within minutes, may be helpful to indicate an anaphylactic reaction specifically involving basophils.⁴ The value of urinary leukotrienes as a diagnostic marker has not been determined and total IgE levels have no diagnostic value.⁴

Patients who present with perioperative anaphylaxis should be evaluated by an allergist in close proximity to the reaction in order to identify the inciting agent to prevent reexposure and potentially fatal outcomes.⁶ To begin, the allergist should request all intraoperative and postoperative records, including medication records and vital signs from the medical facility where the surgery was conducted if these are not available through an electronic medical record. Skin or serologic testing to the suspected agent should be deferred, ideally for 4 to 6 weeks after the reaction, to ensure that mast cells and basophils, respectively, are not refractory to activation.^{3,4} Agents for testing can be obtained with advanced notice from the hospital pharmacy if the patient is in the inpatient setting, or with the help of the anesthesiologist who has access to many of these medications if the patient is being evaluated in the outpatient setting. If there is difficulty obtaining certain medications for testing, it is advisable to refer the patient to an academic center where these agents can be obtained more readily. Percutaneous followed by intracutaneous testing should be performed.^{3,4,28} Because standardized agents are not available for most of these medications, it is important to perform skin testing using nonirritating concentrations in order to avoid false-positive reactions.^{9,79} Mertes and colleagues⁴ published guidelines with nonirritating concentrations of commonly used NMBAs, hypnotics, opioids, local anesthetics, chlorhexidine, and methylene blue. Nonirritating concentrations for some antibiotics have also been published.⁸⁰ When testing for agents with cross-reactive epitopes²⁷ such as local anesthetics, several different agents should be tested.^{3,4} It is important to emphasize that skin testing is to detect IgE antibody and does not identify reactions elicited through nonimmunologic reactions.³ Furthermore, intracutaneous testing can be falsely positive if too high a concentration is tested, causing an irritant reaction. If possible, titration testing in normal control subjects to identify the threshold

concentration causing an irritant-induced response is ideal but this requires institutional review board approval.⁴ Skin testing beginning with very low dilutions of suspected agents, ideally preservative free, should be performed in patients with a highly convincing history of anaphylaxis.³ Skin testing has been shown to be valuable in evaluating anaphylaxis secondary to barbiturates, streptokinase, penicillin, insulin, local anesthetics, and latex.^{3,26} In vitro testing for specific IgE antibodies has been reported for the quaternary ammonium group of muscle relaxants, thiopental, morphine, propofol, and latex.^{3,4} Skin testing is not recommended for preanesthetic screening of subjects without a history of suspected reactions.³

Prevention of anaphylaxis should begin with review of the patient's previous medical records for any history of previous reaction.⁶ In those with latex sensitization, a latex-free operating room should be arranged.^{4,6} Both H1 and H2 antagonists in conjunction with corticosteroids are the most commonly used medications to treat anaphylaxis, although they do not always prevent the progression of a reaction.^{4,81} Manfredi and colleagues⁸¹ proposed a global anaphylactic risk score to identify patients who are at increased risk for anaphylaxis and who may benefit from a pre-medication protocol. Using a scale of calculated risk factors, it places patients into 3 categories of risk and suggests premedication protocols. However, this scale has yet to be validated in large populations. Preoperative corticosteroids may also be beneficial for patients with asthma to prevent asthma-related morbidity.²⁰ Increased use of electronic databases has also been useful for increasing the knowledge gap on appropriate treatment and monitoring of patients with previous perioperative anaphylactic reactions.⁸²

SUMMARY

Perioperative anaphylaxis is becoming more common and thus recognition and evaluation by anesthesiologists in concert with allergists is of paramount importance.^{3,4,7} Reactions require a careful evaluation of the medical and anesthetic record⁴; skin prick and, if appropriate, intracutaneous testing to suspected agents, should be performed 4 to 6 weeks after the event.^{3,4} Risk factors, such as a history of a previous reaction to the inciting agents, a history of latex allergy, a history of ingested medications known to cause anaphylaxis, atopy, and asthma, should be considered before undergoing anesthesia.^{3,4,6,15,18} As shown in the two cases discussed earlier, assessment of patients' asthma control is extremely important because failure to do so can have serious consequences.^{4,6,18,20}

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