



Original Contribution

Variability in anesthesiologists' approach to the preoperative management of asthmatic children^{☆,☆☆}



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Abstract

Objective: No consensus guidelines exist for the preoperative treatment of asthmatic children referred for elective surgery. We investigated the attitude of pediatric anesthesiologists to this issue.

Design: A questionnaire survey was conducted.

Setting: National survey.

Subjects: Certified Israeli pediatric anesthesiologists from all 24 general hospitals in Israel.

Measurement: Twenty-one questions regarding the approach to preoperative management of asthmatic children including 6 case scenarios with a variety of clinical situations and treatments of asthmatic children. The results were compared with the attitude of pediatric pulmonologists recently published using a similar methodology.

Main results: Forty-four pediatric anesthesiologists from all 24 general hospitals in Israel responded. Twenty-five percent of pediatric anesthesiologists answered that, in addition to pediatric anesthesiologists, the primary pediatrician should be consulted, and 70% believed that a pediatric pulmonologists should also be consulted. Overall, results showed a wide variability between responders especially for preschool children and unstable school-aged asthmatic children for both disciplines. The variability referred to the use of any treatment, bronchodilators, inhaled corticosteroids and their combination, addition of systemic corticosteroids, and the length of preoperative treatment. Compared with pediatric pulmonologists, a better within-discipline agreement was observed by the pediatric anesthesiologists for stable school-aged asthmatic children with a lower inclination to augment preoperative treatment ($P < .001$). No difference was observed for the preschool children with asthma and for the unstable school-aged asthmatic child.

Conclusions: A wide variability exists in pediatric anesthesiologists' approach to the preoperative management of asthmatic children for most common case scenarios. This is probably explained by the heterogeneity of asthma, the type of surgery, the lack of guidelines, and the paucity of data. Similarities as well as differences exist between pediatric anesthesiologists and pulmonologists. Further studies and implementation of consensus guidelines are needed.

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1. Introduction

Asthma is the most common chronic disease in children. Almost 10% of children are asthmatic [1-2]. Anesthesia, surgery, and endotracheal intubation in asthmatic children are risk factors for bronchospasm, laryngospasm, perioperative cough, desaturation, and complications related to air trapping [3-6]. In addition, increased cortisol secretion during stress from anesthesia and surgery may be impaired because of the continuous use of inhaled corticosteroids or frequent administration of systemic corticosteroids [7-8]. Findings of studies in adults suggest that preoperative systemic corticosteroids and bronchodilators decrease the incidence of bronchospasm and pulmonary complications [6,8-17]. Hence, elective surgery may require preoperative preparation of some children with asthma. This is also advocated by the Global Initiative for Asthma [18]. Several review articles suggest strategies for the perioperative treatment of the asthmatic adults and children [6,19-22]. Nevertheless, these are not based on controlled studies, and no formal guidelines by either the anesthesiology or respiratory societies have been introduced. In the absence of preoperative guidelines, there is a risk for last-minute unnecessary cancellations of surgery, or potentially, perioperative complications may ensue.

In a national survey among certified pediatric pulmonologists in Israel, we have previously shown that although it was widely accepted that preoperative assessment was required, a large variability in preoperative management of asthmatic children existed [23]. However, because the pediatric anesthesiologists are the professionals who are responsible for the preoperative decisions and are those who actually encounter and assess those patients before surgery, we investigated this problem among this discipline. We hypothesized that because there are no formal recommendations, a uniform management strategy does not exist, and if a variety of approaches was revealed, it would highlight the need for specific guidelines. The aim of this study was, therefore, to evaluate the attitude of pediatric anesthesiologists regarding preoperative management of asthmatic children using a national survey.

2. Methods

A survey regarding preoperative management of children with asthma before elective surgical procedures was sent to all board-certified anesthesiologists who perform pediatric anesthesia. The study was approved by the Institutional Review Board (Helsinki Committee). A signed informed consent was not required for this survey.

The questionnaire was sent by mail, fax, and email or delivered manually to all the directors of anesthesia departments and pediatric anesthesia units in all 24 public hospitals in Israel together with the Israeli Society of Pediatric Anesthesia. The purpose, design, and protocol of the survey were also presented at the annual meeting of the society. The nature

and purpose of the survey were introduced, and the anesthesia directors provided us with the contact details of the anesthesiologists who either were formally responsible for pediatric anesthesia in their institutions (heads of pediatric anesthesia services or units) or were the anesthesiologists who provided anesthesia to children on a regular basis. Anesthesiologists who did not respond and did not return the completed questionnaire within 10 days were reminded by a telephone call or an email message.

Appendix 1 presents the English translation of the questionnaire. The questionnaire included the following sections: (a) demographic and professional information of the responder; (b) multiple choice questions covering 6 case scenarios of clinical situations of asthmatic children at different ages with a variety of asthma severities and receiving a range of different asthma treatment regimens; (c) questions regarding preoperative treatment policy that comprised 2 multiple choice questions; (d) 12 yes/no questions; and (e) a question to verify the personal experience of the responder as a pediatric anesthesiologist. The questionnaire comprised the following treatment issues: the option of 1 intravenous corticosteroid injection after an IV was inserted for anesthesia just before surgery (as either the sole preoperative treatment or in addition to several days of other preoperative management), risk factors that might alter the anesthesiologist's decision, the use of pulmonary function testing in the decision making, and a question on who should be involved in the decision making of preoperative treatment (anesthesiologist alone, pulmonologist, or pediatrician).

Overall, the 6 case scenarios covered diverse common clinical situations. For each of the multiple choice questions regarding the 6 scenarios, the participants were asked to mark their approach out of 6 preoperative treatment strategies (1 strategy or more) which included the following options: (1) no treatment at all; (2) short-acting beta-agonist in the morning of surgery; (3) combination of inhaled corticosteroids and short-acting beta-agonist for 1-3 days; (4) the same combination for 4-7 days; (5) oral systemic corticosteroid 1-5 days before surgery; and (6) intravenous corticosteroids in the morning of surgery after placing an IV according to the surgery's plan (either before or after induction). In a note that accompanied each questionnaire, we commented that more than one answer may apply and that the responder should pay attention that choices may contradict. Table 1 presents a summary of the 6 case scenarios and clarifies the classification of the asthmatic patients as stable or unstable.

Risk factors that might affect the pediatric anesthesiologists' decision to augment treatment before surgery were assessed by 11 prestructured yes/no questions that covered the following possible factors: (1) an exacerbation during the last month; (2) past admission to a pediatric intensive care unit (PICU) due to asthma; (3) being on high-dose inhaled corticosteroids; (4) the use of >2 weeks of systemic corticosteroids during the last 6 months; (5) night cough for more than 2 nights per week; (6) type of surgery; (7) smoking (active or

Table 1 Summary of the 6 case scenarios

Scenario no. (question no.)	Age (y)	Patient is on continuous controller medications	Comments	Case characteristics
1 (2)	9	No	Exacerbation every 1-2 mo	School-aged boy not completely stable without controller medications
2 (3)	8	No	Exacerbation every 6 mo	Stable school-aged boy without controller medications
3 (4)	2	Low-dose ICS	No exacerbation in the past few months	Stable preschool girl on low-dose ICS
4 (5)	2	Low-dose ICS	2 courses of systemic corticosteroids in the past 6 mo	Unstable preschool boy on low-dose ICS
5 (6)	13	Medium-dose ICS + LABA	1-2 exacerbation per month	Unstable school-aged boy on moderate ICS and LABA
6 (7)	7	No	History of PICU (3 y old)	Stable school-aged boy without controller medications past PICU admission

ICS = inhaled corticosteroids, LABA = long-acting beta-agonist.

passive); (8) body mass index (BMI) above 95%; (9) exacerbation during the last 6 months before surgery; (10) hospitalization during the last month other than for asthma exacerbation; and (11) family history of atopy.

In a previous study, we evaluated the approach of pediatric pulmonologists to preoperative treatment of asthmatic children using the same methodology and the same questionnaire [23]. Hence, the results were also compared with the findings of the pediatric pulmonologist discipline. A permission to use published data for comparison was obtained from the *Journal of Asthma*.

2.1. Statistical analysis

Statistical analysis was performed by a biostatistician with the use of SPSS (Chicago, IL) version 21. The data are presented as percentage of treatment strategies for each of the 6 clinical scenarios. χ^2 tests were used for categorical data to compare positive responses between groups. Two-tailed p values of $<.05$ were considered significant. Data are also presented as a bar graph figure. Whenever a question was not answered by all participants, the ratios were calculated by the number of survey recipients who did respond.

3. Results

3.1. Pediatric anesthesiologists' approach to the preoperative management of children with asthma

Forty-four pediatric anesthesiologists from all 24 public hospitals in Israel responded; 868 of a total of 924 questions were answered (94%). Table 2 summarizes the characteristics of the 44 responders.

All pediatric anesthesiologists (100%) believed that preoperative treatment should be considered in all asthmatic children, regardless of their disease state. IV corticosteroids

before surgery was advocated by the majority of the pediatric anesthesiologists (38/44, 86%), yet only 5% suggested the routine application of this strategy in all asthmatic children. The remainder supported IV corticosteroids only according to individual clinical considerations such as increased risk for adrenal insufficiency (50%) due to maintenance treatment with either low- or high-dose inhaled corticosteroids (27% and 50%, respectively) and in the case of an asthma exacerbation in the past 2 months (20.5%).

In addition to preoperative assessment by the pediatric anesthesiologists, 45% suggested that a pulmonary consultation is warranted in individual cases, 25% recommended pulmonary consultation in all asthmatic cases, 25% recommend primary pediatrician consultation, and 5% did not advocate the involvement of any other discipline in addition to the pediatric anesthesiologists.

The results of the 6 case scenarios are presented in Table 3. All the responses were grouped and analyzed to form treatment strategies (the relationship between the questionnaire items and the treatment strategies appears at the bottom of Appendix 1).

The majority of the participants routinely augment baseline controller treatment before surgery for the following scenarios: asthma exacerbation during the last month (73%), PICU hospitalization anytime in the past (68%), being on high-

Table 2 Characteristics of the pediatric anesthesiologists

Characteristics	Responders (n = 44)
Male	39 (83%)
Experience of practicing pediatric anesthesia (n = 38) ^a	
<5 y	16%
5-10 y	21%
5-10 y	23%
15 < y	39%

Results are shown as absolute and percentage counts: n (%).

^a Years of practicing pediatric anesthesia since board certification in anesthesia.

Table 3 The distribution of positive responses to specific treatment options for the 6 scenarios

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
No TX	5%	32.5%	16%	7%	12.5%	25%
SABA alone	20%	42%	39%	9%	35%	30%
SABA + ICS 1 ^a	36%	21%	20.5%	25%	42.5%	22%
SABA + ICS 2 ^b	10%	5%	4.5%	16%	7.5%	11%
PO CS ^c	10%	0%	4.5%	9%	0%	3%
SABA + PO CS	2.5%	0%	2.5%	9%	0%	3%
SABA + ICS + PO CS	13%	0%	11.5%	16%	2.5%	3%
IV CS alone ^d	2.5%	0%	2%	9%	0%	3%
IV CS total ^e	43%	9%	25%	39%	16%	21%
PFT before surgery	27%	4.5%	IR	IR	11.5%	21%

All numbers are presented as percentage of positive answers. CS = corticosteroids, IR = irrelevant, PFT = pulmonary function testing, Tx = treatment.

^a SABA + ICS1: short-acting beta-agonist and inhaled corticosteroids for 1-3 days.

^b SABA + ICS2: short-acting beta-agonist and inhaled corticosteroids for 4-7 days.

^c PO CS: oral corticosteroids 1-5 days before surgery.

^d As the only treatment (no treatment at home).

^e IV CS total: either alone or in addition to other treatment.

dose inhaled corticosteroids (78%), >2 weeks of systemic corticosteroids during the 6 months before surgery (83%), night cough more than 2 nights per week (71%), and type of surgery (68%). Only a minority of the pediatric anesthesiologists augment long-term treatment for the following scenarios: smoking (active or passive) (40%), BMI above 95% (29%), exacerbation during the last 6 months (excluding the last month) before the surgery (15%), and a family history of atopy (10%). Years of practice of pediatric anesthesia post board certification in anesthesia (<5 years, 5-10 years, 10-15 years, and >15 years) did not affect the responses.

3.2. Comparison of pediatric anesthesiologists' to pediatric pulmonologists' approach

Comparison of pediatric anesthesiologists' responses to those of the pediatric pulmonologists for the 6 scenarios is presented in Fig. 1. A different approach was observed between the 2 disciplines ($P < .001$) for scenarios 1 and 2 (Fig. 1A and B), that is, stable and the not completely stable school-aged asthmatic children who are not on controller medication, where the distribution of pediatric anesthesiologists approach showed a better agreement with a significantly less variability. Pediatric anesthesiologists were also less likely to augment or start additional preoperative treatment in this scenario. In these 2 scenarios, compared with 38% and 32% of the pediatric pulmonologists, only 11.5% and 4.5% of the pediatric anesthesiologists, respectively, recommended pulmonary function testing before anesthesia and surgery ($P < .001$).

Similar heterogeneity was observed among both disciplines ($P = .628$) regarding the management of the stable preschool asthmatic child who is treated with low-dose inhaled corticosteroids (scenario 3, Fig. 1C) and the management of the unstable preschool asthmatic child who is treated with low-dose inhaled corticosteroids ($P = .116$) (scenario 4, Fig. 1D). Similar

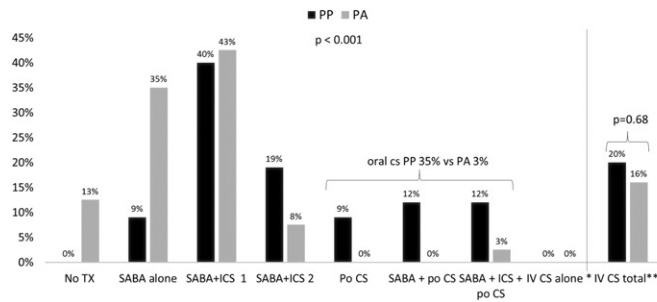
heterogeneity was observed among both disciplines ($P = .07$) also regarding the unstable school-aged asthmatic child on moderate-dose inhaled corticosteroids and long-acting beta-agonists (scenario 5, Fig. 1E), and no difference in the use of pulmonary function testing (pediatric anesthesiologists = 27%, pediatric pulmonologists = 44%; $P = .091$) was observed. The distribution of pediatric anesthesiologists' approach showed a better agreement with a significantly less variability ($P = .01$) for scenario 6 (Fig. 1F), that is, the stable school-aged asthmatic child without controller medications with a history of PICU admission. Compared with 46% of the pediatric pulmonologists, only 21% of the pediatric anesthesiologists suggested to use pulmonary function testing before anesthesia and surgery ($P = .014$). No difference was found between pediatric anesthesiologists and pediatric pulmonologists regarding risk factors that affected the decision to augment treatment before surgery.

4. Discussion

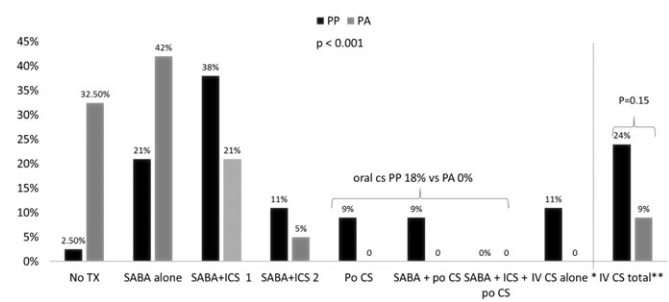
This study demonstrates a considerable variability in the preoperative treatment strategies of asthmatic children by pediatric anesthesiologists in common clinical scenarios. All pediatric anesthesiologists agreed that the asthmatic child should be routinely assessed for the need for preoperative asthma treatment. The distribution of responses to the stable or incompletely stable school-aged asthmatic child including the scenario of a child with a history of PICU admission showed a relatively better agreement and a much less aggressive approach compared with the approach to the unstable school-aged child and the stable or unstable preschool child.

At present, it is not well established whether and how children with asthma should be managed before elective anesthesia and surgery and the effects of patient's age and asthma

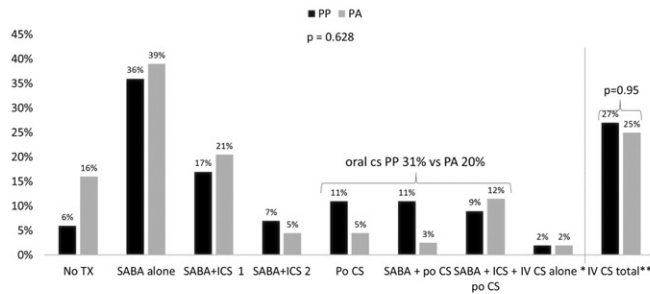
A: scenario 1



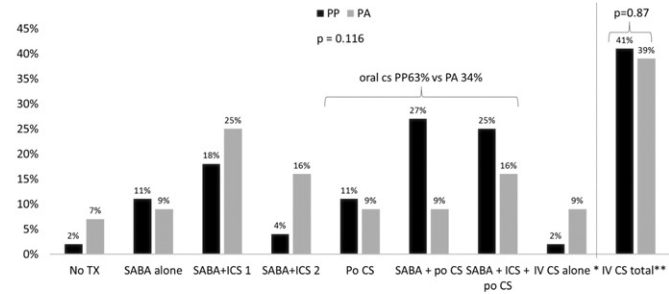
B: scenario 2



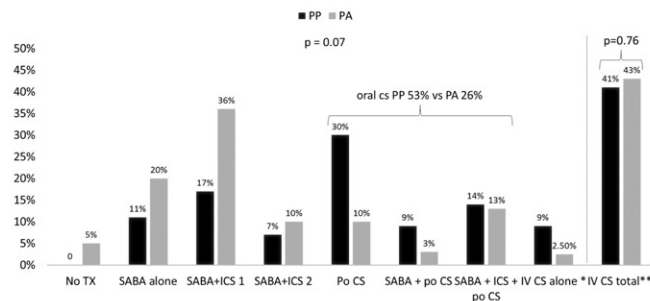
C: scenario 3



D: scenario 4



E: scenario 5



F: scenario 6

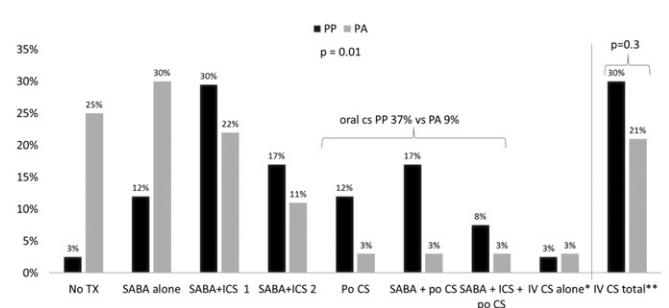


Fig. 1 Distribution of pediatric anesthesiologists' approach to the 6 clinical scenarios and comparison to pediatric pulmonologists. (A) Scenario 1: an incompletely stable school-aged boy without controller medications. (B) Scenario 2: a stable school-aged boy without controller medications. (C) Scenario 3: a stable preschool girl on low-dose inhaled corticosteroids. (D) Scenario 4: an unstable preschool boy on low-dose inhaled corticosteroids. (E) Scenario 5: an unstable school-aged boy on moderate-dose inhaled corticosteroids and long-acting beta-agonists. (F) Scenario 6: a stable school-aged boy without controller medications past history of PICU admission. *IV CS alone: as the only treatment (no treatment at home). **IV CS total: either alone or in addition to other treatment.

history on such management. We have previously shown the diversity among the pediatric pulmonologists for the preoperative treatment approach [23]. In the current study, we outline the opinions of pediatric anesthesiologists and compare their strategies to pediatric pulmonologists. The rationale is that both disciplines manage asthmatic children but from different points, that is, for different time lengths, for different purposes, and different clinical states of the disease; nevertheless, both may be involved in the decision making of the need and way to prepare an asthmatic child to an elective surgery.

The rationale to consider medical preparation of asthmatic children before surgical procedures is the increased risk for complications during the procedure. Von Ungern-Sternberg et al showed that exercise-induced asthma and at least 3

episodes of wheezing in the last 12 months before surgery were associated with a higher risk for laryngospasm, bronchospasm, perioperative cough, desaturation, and airway obstruction [3]. This is supported also by other publications [6,24,25]. All the participants agreed that asthmatic children should be routinely assessed for the need of preoperative asthma treatment, and the majority advocated the involvement of pediatric pulmonologists in all or selected cases. This team approach is highly supported by other studies as well [6,18-20].

The major difference between pediatric anesthesiologists and pediatric pulmonologists concerned the stable school-aged asthmatic child where pediatric anesthesiologists use less aggressive treatment, are more consistent, and apply a less diverse approach compared with pediatric pulmonologists. This

may be explained by the fact that pediatric pulmonologists provide recommendation “from a distance,” that is, are less familiar and feel less comfortable with the response to any asthmatic manifestation during surgery, whereas the pediatric anesthesiologists feel more in control if a complication occurs during surgery under their responsibility. It should be noted that unlike pediatric anesthesiologists who see most asthmatic children when they are stable, the pediatric pulmonologists are usually consulted in asthmatic children who may be unstable. Their interpretation of the term *exacerbation* might also differ. This rationale also explains why this difference disappears for unstable school-aged asthmatic children and in the 2 case scenarios of preschool children. The similar large variability in responses for these latter 3 scenarios may also result from the higher uncertainty regarding the more difficult cases including those children who may respond less to acute treatment if a complication occurs during surgery (ie, small preschool children). This is also manifested by the similar approach of pediatric anesthesiologists and pediatric pulmonologists for the risk factors that should lead to augmentation of treatment. Despite the variability in approaches observed by the 2 disciplines, both agreed that, overall, medical treatment should be intensified in most children, especially those who are already on preventive medications or had recent exacerbations, to minimize bronchial hyperactivity and airflow obstruction. The wide variability observed could be explained by the heterogeneous nature of asthma characterized by chronic airway inflammation [18]. Another factor that might have contributed to the variability is the different kinds of surgical procedures which may necessitate different approaches.

Analyzing the data according to years of experience showed that years of practice in pediatric anesthesia since receiving board certification did not affect the results. This may not be surprising because the more experienced pediatric anesthesiologists guide and influence the younger generations who follow their strategies.

Pulmonary function testing was advocated by a substantially higher rate of pediatric pulmonologists compared with pediatric anesthesiologists probably because of the familiarity of pediatric pulmonologists with this tool and their routine use of pulmonary function testing in their practice. No studies were found to justify the routine use of this tool in this setting [6,17].

One limitation of this study is that we collected data on attitudes about management of hypothetical scenarios and not actual practice data. A difference between these potentially occurs because physicians may act differently in the specific case compared with their general approach to a theoretic clinical scenario. Another limitation is that unlike the pediatric pulmonologist subspecialty, there is no certified subspecialty for pediatric anesthesiologists in Israel (as opposed to United States but similar to most European countries). Therefore, the questionnaires were conveyed through the directors of anesthesia departments and pediatric anesthesia units in all 24 public hospitals in Israel. They nominated only pediatric anesthesiologists to participate. Because we received at least 1 questionnaire from each hospital in Israel, we believe that this represents the overall attitude of the pediatric

anesthesiologists in our country. Our survey was conducted only in Israel; hence, more data also from other countries may improve the present conclusions.

Lastly, because it is common in a group practice for the person who makes the preoperative preparation recommendations not to be the same person who anesthetizes, the opportunity for feedback about the efficacy of the recommendations may be limited, and the strategy of asthmatic preparation depends on the anesthesiologist who makes the preoperative assessment rather than on the pediatric anesthesiologist who provides the anesthesia. This further emphasizes the need for guidelines.

5. Conclusions

The present study highlights the lack of standardization even in this homogeneous group of professionals in relation to a clinical situation. This is probably explained by the heterogeneity of asthma, the type of surgery, the lack of guidelines, and the paucity of data. Consequently, we suggest that professional societies discuss incorporating this subject into their agenda, endorse prospective controlled studies, and consider the development of a consensus statement and practice guidelines based on data and expert opinion.

Acknowledgments

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Appendix 1. Preoperative questionnaire

Demographic details

Name of hospital: _____

Number of years practicing pediatric anesthesiology: _____

Part A:

1. Do you routinely recommend IV corticosteroids in the morning of surgery as your general practice?
 - a. For all the asthmatic children
 - b. Only when I suspect adrenocortical insufficiency
 - c. Only when the patient requires other preoperative treatment.
 - d. No
 - e. Only when the patient is treated with any dosage of inhaled corticosteroids as long-term treatment.
 - f. Only when the patient is treated with inhaled corticosteroids and long-acting beta-agonists as long-term treatment.
 - g. Only when the patient is treated with high-dose inhaled corticosteroid as long-term treatment.
 - h. Only when the patient had an asthma exacerbation in the past 2 months before surgery.

- i. Only when the patient had an asthma exacerbation in the past year before surgery.
 2. A nine-year-old asthmatic boy, diagnosed with asthma since 2 years old. No prophylactic treatment. Asthma exacerbation once in 1-2 months. What would you recommend as preoperative treatment (one answer or more)?
 - a. No treatment at all
 - b. Short-acting beta-agonist (SABA) in the morning of surgery
 - c. Combination of ICS and SABA for 1-3 days
 - d. Combination of ICS and SABA for 4-7 days
 - e. Oral systemic corticosteroid 1-5 days before surgery
 - f. Intravenous corticosteroids in the morning of surgery
 - g. Pulmonary function testing before surgery
 3. An eight-year-old asthmatic boy diagnosed with asthma since 2 years old. No prophylactic treatment. Asthma exacerbation once in 6 months. No exacerbation in the past 6 weeks. What would you recommend as preoperative treatment (one answer or more)?
 - a. No treatment at all
 - b. Short-acting beta-agonist (SABA) in the morning of surgery
 - c. Combination of ICS and SABA for 1-3 days
 - d. Combination of ICS and SABA for 4-7 days
 - e. Oral systemic corticosteroid 1-5 days before surgery
 - f. Intravenous corticosteroids in the morning of surgery
 - g. Pulmonary function testing before surgery
 4. A two-year-old girl with recurrent episodes of dyspnea and wheezing. She is on daily fluticasone 125 μ g twice a day via a spacer. No exacerbation in the past few months. What would you recommend as preoperative treatment (one answer or more)?
 - a. No treatment at all
 - b. Short-acting beta-agonist (SABA) in the morning of surgery
 - c. Combination of ICS and SABA for 1-3 days
 - d. Combination of ICS and SABA for 4-7 days
 - e. Oral systemic corticosteroid 1-5 days before surgery
 - f. Intravenous corticosteroids in the morning of surgery
 5. A two-year-old boy with recurrent episodes of dyspnea and wheezing. Patient is on fluticasone 125 μ g twice a day via a spacer. Patient was treated with 2 courses of oral bethametasone for 5 days in the past 6 months. What would you recommend as preoperative treatment (one answer or more)?
 - a. No treatment at all
 - b. Short-acting beta-agonist (SABA) in the morning of surgery
 - c. Combination of ICS and SABA for 1-3 days
 - d. Combination of ICS and SABA for 4-7 days
 - e. Oral systemic corticosteroid 1-5 days before surgery
 - f. Intravenous corticosteroids in the morning of surgery
 6. A thirteen-year-old asthmatic boy diagnosed with asthma since age 4 years. Patient is on a daily combination of a medium-dose ICS and a long-acting beta-agonist (LABA) (fluticasone 250 μ g combined with salmeterol 50 μ g disc twice daily as long-term treatment). Patient had 1 to 2 asthma exacerbations per month. What would you recommend as preoperative treatment (one answer or more)?
 - a. No treatment at all
 - b. Short-acting beta-agonist (SABA) in the morning of surgery
 - c. Combination of ICS and SABA for 1-3 days
 - d. Combination of ICS and SABA for 4-7 days
 - e. Oral systemic corticosteroid 1-5 days before surgery
 - f. Intravenous corticosteroids in the morning of surgery
 - g. Pulmonary function testing before surgery
 7. A seven-year-old asthmatic boy was admitted to the Pediatric Intensive Care Unit for asthma when he was 3 years old. Since then, he has 2 asthma exacerbations per year. No prophylactic treatment. What would you recommend as preoperative treatment (one answer or more)?
 - a. No treatment at all
 - b. Short-acting beta-agonist (SABA) in the morning of surgery
 - c. Combination of ICS and SABA for 1-3 days
 - d. Combination of ICS and SABA for 4-7 days
 - e. Oral systemic corticosteroid 1-5 days before surgery
 - f. Intravenous corticosteroids in the morning of surgery
 - g. Pulmonary function testing before surgery
 8. Who do you think should be involved in the preoperative treatment recommendations for an asthmatic child?
 - a. Only an anesthesiologist
 - b. A pediatrician
 - c. A pediatric pulmonologist in all cases
 - d. A pediatric pulmonologist only in special circumstances
- Part B:**
- This section deals with your general approach to preoperative management for the asthmatic child.
9. In your general practice, are you involved in the preoperative treatment recommendations for an asthmatic child? yes / no
- Which of the following factors might affect your decision regarding the preoperative treatment recommendation?
10. an exacerbation during the last month; yes / no
 11. past admission to a pediatric intensive care unit; yes / no
 12. being on high-dose ICS; yes / no
 13. the use of >2 weeks of systemic CS during the last 6 months; yes / no

14. night cough for more than 2 nights per week; yes / no
15. type of surgery; yes / no
16. smoking active or passive; yes / no
17. BMI above 95%; yes / no
18. exacerbation during the last 6 months before surgery; yes / no
19. hospitalization during the last month, other than for asthma exacerbation; yes / no
20. family history of atopy; yes / no

Part C:

21. Whenever a child in your hospital needs anesthesia and surgery, while you are on service, are you the anesthesiologist who provides the anesthesia? Yes / no

Clarification for Fig. 1:

Treatment strategies were composed by grouping the different responses and are presented on the x-axis.

Treatment strategies:

- No Tx: responders who chose only item “a”
- SABA alone: responders who chose only item “b”
- SABA + ICS-1: responders who chose only item “c”
- SABA + ICS-2: responders who chose only item “d”
- P.O. CS: responders who chose only item “e”
- SABA + P.O. CS: responders who chose items “b” + “e”
- SABA + ICS+P.O. CS: responders who chose either items “c” + “e” or items “d” + “e”
- IV CS alone: responders who chose only item “f”
- IV CS total: all responders who chose item “f” (alone or in combination with other items)

References

- [1] Pearce N, Ait-Khaled N, Beasley R, Mallol J, Keli U, Mitchell E, et al. The ISAAC phase Three Study Group: worldwide trends in the prevalence of asthma symptoms: phase III of the International Study of Asthma and Allergies in Childhood (ISAAC). *Thorax* 2007;62:758-66.
- [2] Bloom B, Cohen RA, Freeman G. Summary health statistics for U.S. children: National Health Interview Survey. 2007. *Vital Health Stat* 2009;10:1-80.
- [3] Von Ungern-Sternberg BS, Boda K, Chambers NA, Rebmann C, Johnson C, Sly PD, et al. Risk assessment for respiratory complications in paediatric anaesthesia: a prospective cohort study. *Lancet* 2010;376:773-83.
- [4] Orestes M, Lander L, Verghese S, Shah RK. Incidence of laryngospasm and bronchospasm in pediatric adenotonsillectomy. *Laryngoscope* 2012; 122:425-8.
- [5] Regli A, von Ungern-Sternberg BS. Anesthesia and ventilation strategies in children with asthma: part I - preoperative assessment. *Curr Opin Anaesthesiol* 2014;27:288-94.
- [6] Dones F, Foresta G, Russotto V. Update on perioperative management of the child with asthma. *Pediatr Rep* 2012;2:4(2).
- [7] Smith RW, Downey K, Gordon M, Hudak A, Meeder R, Barker S, et al. Prevalence of hypothalamic-pituitary-adrenal axis suppression in children treated for asthma with inhaled corticosteroids. *Pediatr Child Health* 2012;17:e34-9.
- [8] Su FW, Beckman DB, Yarnold PA, Grammer LC. Low incidence of complications in asthmatic patients treated with preoperative corticosteroids. *Allergy Asthma Proc* 2004;25:327-33.
- [9] Mitsuta K, Shimoda T, Fukushima C, Obase Y, Ayabe H, Matsuse H, et al. Preoperative steroid therapy inhibits cytokine production in the lung parenchyma in asthmatic patients. *Chest* 2001;120:175-83.
- [10] Kobalin CS, Yarnold PR, Grammer LC. Low complication rate of corticosteroid-treated asthmatics undergoing surgical procedures. *Arch Intern Med* 1995;155:1379-84.
- [11] Silvanus MT, Groeben H, Peters J. Corticosteroids and inhaled salbutamol in patients with reversible airway obstruction markedly decrease the incidence of bronchospasm after tracheal intubation. *Anesthesiology* 2004;100:1052-7.
- [12] Scalfaro P, Sly PD, Sims C, Habre W. Salbutamol prevents the increase of respiratory resistance caused by tracheal intubation during sevoflurane anesthesia in asthmatic children. *Anesth Analg* 2001;93: 898-902.
- [13] Groeben H, Silvanus MT, Beste M, Peters J. Combined lidocaine and salbutamol inhalation for airway anesthesia markedly protects against reflex bronchoconstriction. *Chest* 2000;118:509-15.
- [14] Maslow AD, Regan MM, Israel E, Darvish A, Mehrez M, Boughton R, et al. Inhaled albuterol, but not intravenous lidocaine, protects against intubation-induced bronchoconstriction in asthma. *Anesthesiology* 2000;93:1198-204.
- [15] Ie K, Yoshizawa A, Hirano S, Izumi S, Hojo M, Sugiyama H, et al. A survey of perioperative asthmatic attack among patients with bronchial asthma underwent general anesthesia. *Arerugi* 2010;59:831-8.
- [16] Expert Panel Report 3 (EPR-3) Guidelines for the diagnosis and management of asthma—summary report 2007J Allergy Clin Immunol 2007; 120:S94-138.
- [17] Stasic AF. Perioperative implications of common respiratory problems. *Semin Pediatric Surg* 2004;13:174-80.
- [18] Global strategy for asthma management and prevention, Global Initiative for Asthma (GINA) 2015. www.ginasthma.org. [updated April, 2015].
- [19] Liccardi G, Salzillo A, De Blasio F, D'Amato G. Control of asthma for reducing the risk of bronchospasm in asthmatics undergoing general anesthesia and/or intravascular administration of radiographic contrast media. *Curr Med Res Opin* 2009;25:1621-30.
- [20] Lauer R, Vadi M, Mason L. Anaesthetic management of the child with co-existing pulmonary disease. *Br J Anaesth* 2012;109:i47-59.
- [21] Busse WW, Kiecolt-Glaser JK, Coe C, Martin RJ, Weiss ST, Parker SR. NHLBI workshop summary. Stress and asthma. *Am J Respir Crit Care Med* 1995;151:249-52.
- [22] Yamakage M, Iwasaki S, Namiki A. Guideline-oriented perioperative management of patients with bronchial asthma and chronic obstructive pulmonary disease. *J Anesth* 2008;22(4):412-28.
- [23] Armoni-Domany K, Gut G, Soferman R, Sivan Y. Pediatric pulmonologists approach to the pre-operative management of the asthmatic child. *J Asthma* 2014;2:1-7.
- [24] Santandreu AJ, Alavedra Peñalba AS. Pulmonary atelectasis during anesthesia in a boy with upper respiratory tract infection. *Rev Esp Anestesiología Reanim* 2001;48:188-91.
- [25] Komasa N, Ueki R, Kusuyama K, Okano Y, Tatara T, Tashiro C. Case of tension pneumothorax associated with asthma attack during general anesthesia. *Masui* 2010;59:614-7.