2025년 11월 22일(토) Airway School 2025
16:30~17:00

Asthma : Management & Prevention of Acute Exacerbations

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나용섭

Contents

1. Definition and Risk factors of Asthma exacerbations
2. Managing modifiable risk factors
3. Diagnosis of asthma exacerbations
4. Management of asthma exacerbations
5. Conclusion

Asthma is often inappropriately treated as a recurrent acute disease, with no treatment in between

- Burden to patients, family, health system, economy
- Risk of asthma mortality
- Cumulative risk of adverse effects of oral corticosteroids, with even 4–5 lifetime courses *(Price, 2018)*
- Asthma morbidity and mortality are largely preventable

Box 9-3. Optimizing asthma treatment to minimize need for OCS

Optimize asthma treatment to minimize cumulative adverse effects of OCS use

- OCS can be life-saving during severe asthma exacerbations, but there is increasing awareness of the risks of single and repeated courses.
- In adults, short-term adverse effects of OCS include sleep disturbance, increased appetite, reflux, mood changes,[760] sepsis, pneumonia, and thromboembolism.[592]
- In adults, even 4–5 lifetime courses of OCS are associated with a significantly increased dose-dependent risk of diabetes, cataract, heart failure, osteoporosis and several other conditions.[234]
- The need for OCS can be reduced by optimizing asthma therapy, including ICS-containing medications, treating modifiable risk factors, using relevant non-pharmacological strategies, and providing education and skills training, including inhaler technique and adherence. Refer patients for expert advice if needed (Box 3-8, p.66).
- Make sure that all patients are receiving ICS-containing therapy. For adults and adolescents, GINA Track 1 with ICS-formoterol as anti-inflammatory reliever reduces the risk of severe exacerbations requiring OCS, compared with using a SABA reliever (see Box 4-6, p.77).
- All patients should have a written asthma action plan, showing them how to increase their inhaled medications and when to contact medical care.

ICS: inhaled corticosteroid; OCS: oral corticosteroids; SABA: short-acting beta$_2$-agonist.

GINA goal of asthma management

The goal is to achieve the **best possible long-term asthma outcomes** for each patient:

- Long-term symptom control, which may include:
  - Few/no asthma symptoms, quickly relieved
  - No sleep disturbance
  - Unimpaired physical activity
- Long-term asthma risk minimization, which may include:
  - No exacerbations
  - Improved or stable personal best lung function
  - No requirement for maintenance oral corticosteroids
  - No medication side-effects

When discussing best possible long-term outcomes with a patient, consider:

- Their asthma phenotype
- Clinical features
- Multimorbidity
- Risk factors (e.g. poor adherence, smoking, persistent airflow limitation)
- Availability, cost and adverse effects of medications
- The patient's goals (these may be different from medical goals)

- Assessing symptom control is not enough! Patients with few asthma symptoms can still have severe or fatal exacerbations related to individual risk factors or external triggers (viruses, allergen, pollution)
- Encourage referral for expert advice for patients with difficult-to-treat or severe asthma

Prevalence of asthma attacks and mortality

National

Prevalence of Asthma Attacks[1] Among Children and Adults With Current Asthma[2] (2021)

Characteristic	Weighted Number With Asthma Attack[1]	Percent[3] (SE)
Total	**9,818,458**	**39.4 (1.05)**
Children (Age <18 years)	1,811,063	38.7 (2.51)
Adults (Age 18+ years)	8,007,395	39.6 (1.18)

Asthma Mortality by Select Sociodemographic Characteristics (2021)

Characteristic[1]	Number of Deaths[2]	Death Rate[2] Per Million (SE)
Total	**3,517**	**10.6 (0.18)**
Children (Age <18 years)[3]	145	2.0 (0.16)
Adults (Age 18+ years)[4]	3,372	13.1 (0.22)

Source: National Center for Environmental Health

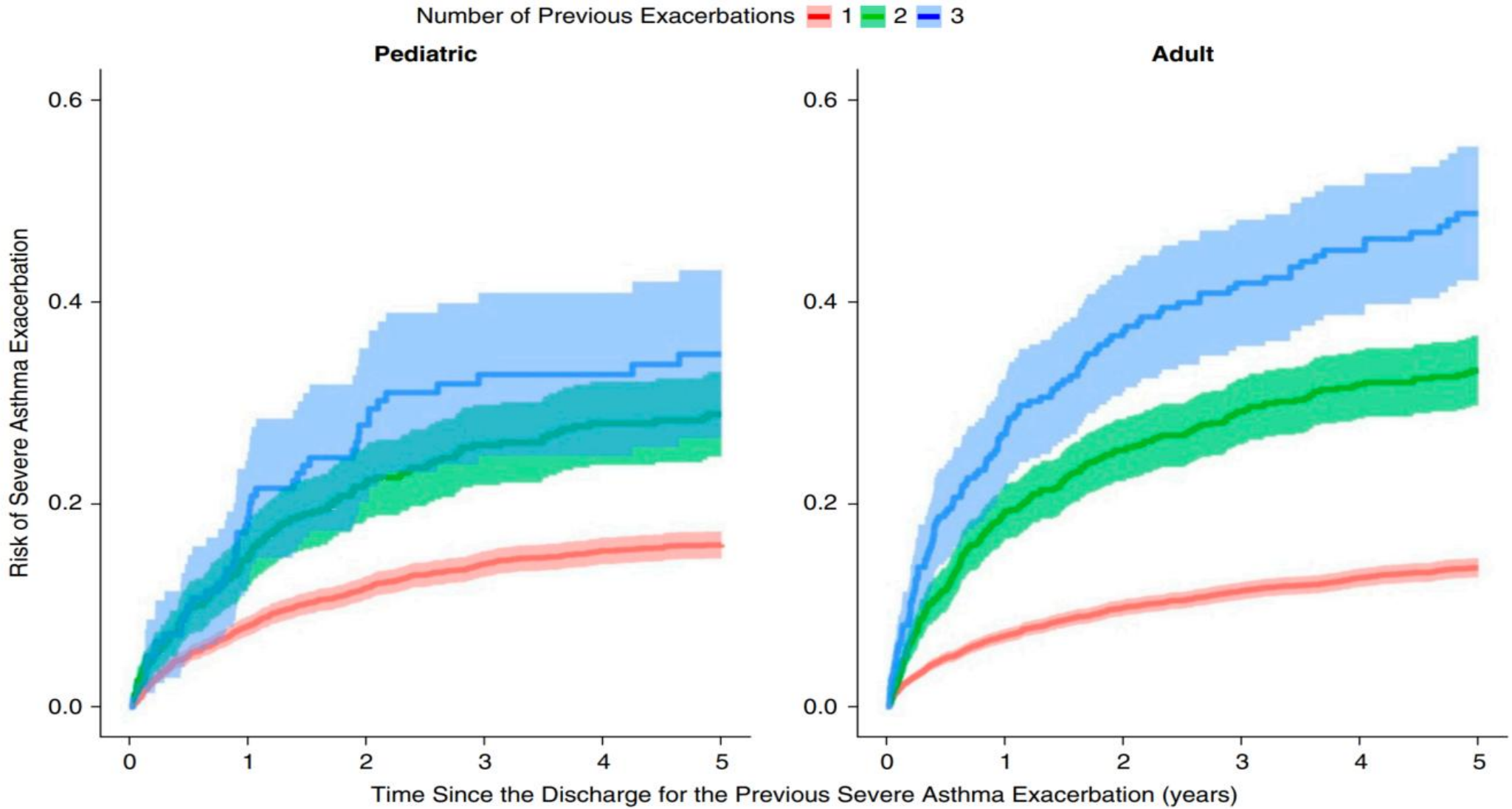


Figure 2. Cumulative incidence curves since discharge for the previous severe exacerbation for the first three follow-up events (first: red, second: green, and third: blue) for the pediatric and adult groups. The shaded area corresponds to pointwise 95% confidence intervals.

Ann Am Thorac Soc. 2022 Jun;19(6):907-915.

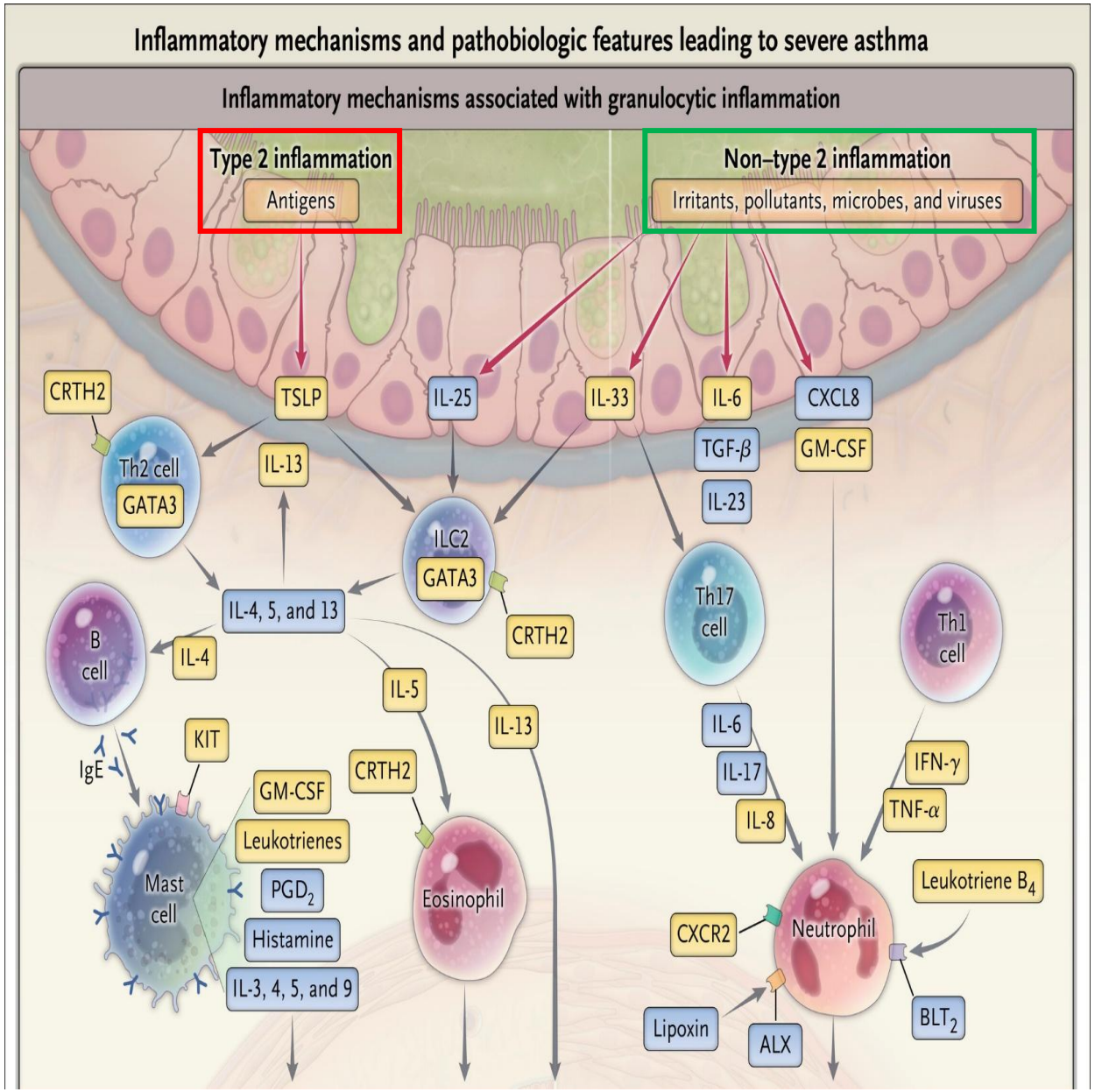
Definition and Risk factors of Asthma exacerbations (prevention of exacerbations)

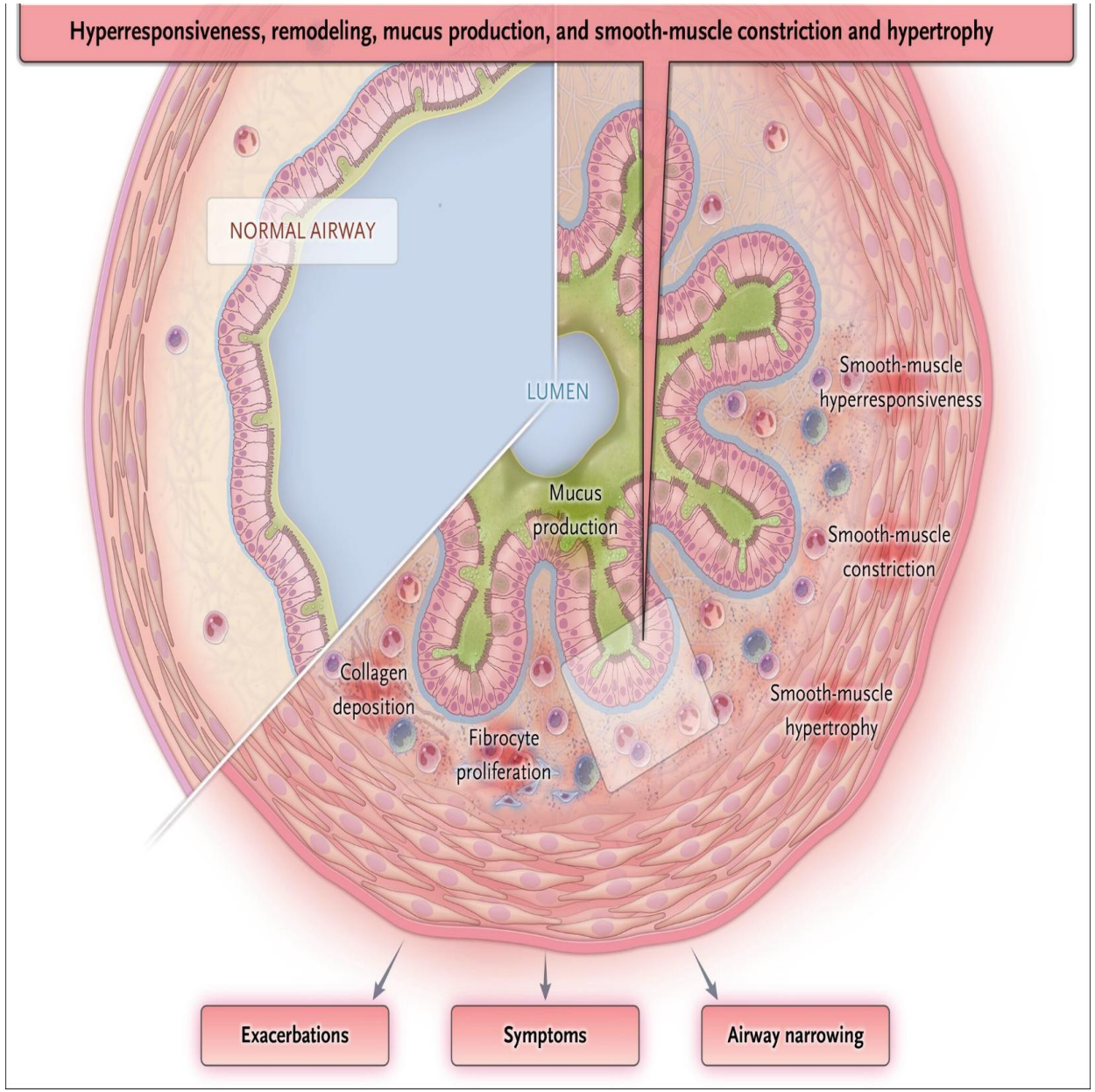
Definition of asthma exacerbations

- An **acute or sub-acute worsening in symptoms and lung function** from the patient's usual status, or in some cases, a patient may present for the first time during an exacerbation
  (GINA 2025)
- 호흡곤란, 기침, 천명, 또는 가슴답답함과 같은 증상이 지속적으로 나빠지고, 폐기능이 지속적으로 감소되는 상황, 즉, 환자의 상태가 일상적인 수준에서 변화하여 치료의 변화가 필요하게 되는 상황으로 천식의 첫 발현으로 나타나기도 한다.
  (2022 천식 진료지침)

흔한 천식 악화 유발 요인

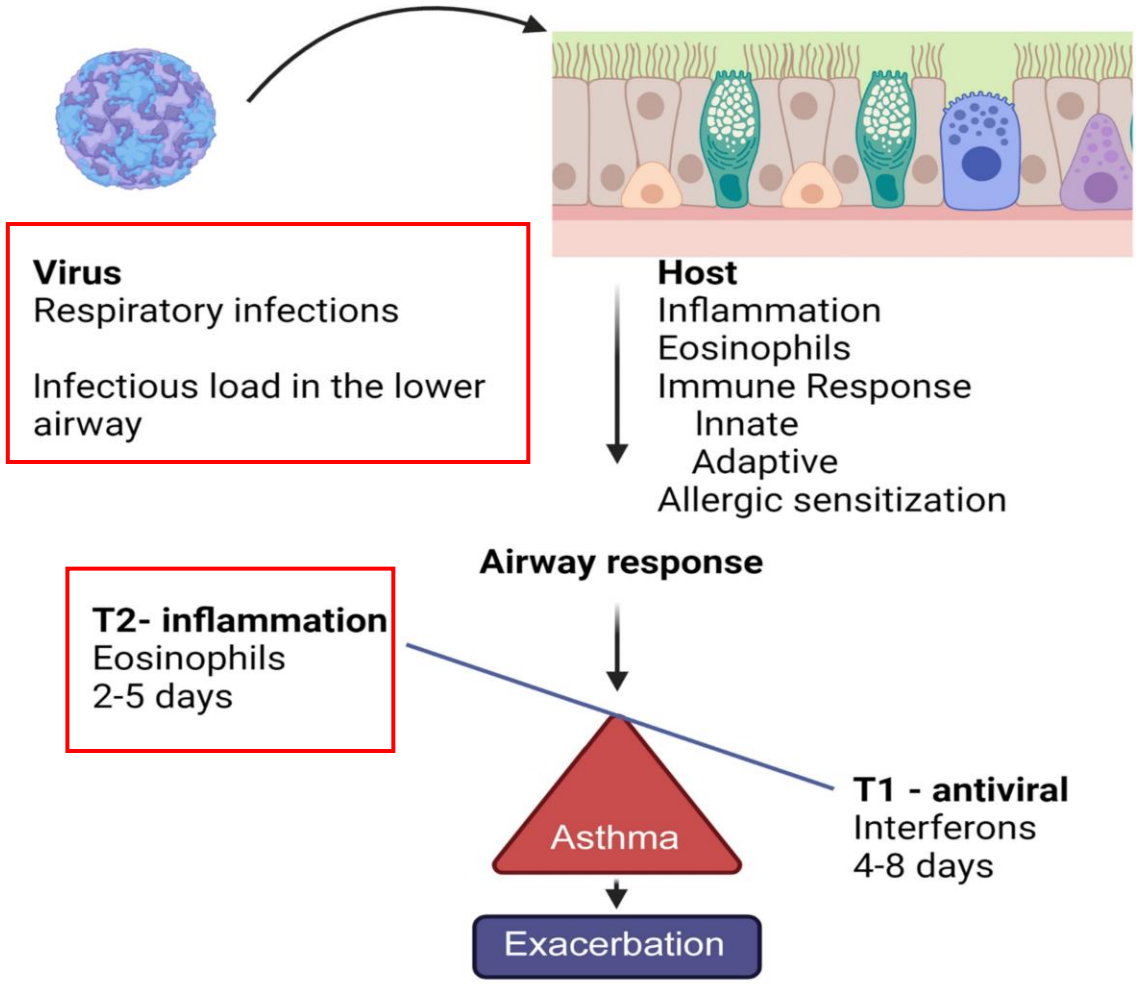
주요 악화 요인	세부 내용 및 예시
바이러스성 호흡기 감염	Rhinovirus, Influenza, Adenovirus, Pertussis, RSV, Coronavirus 등
알레르겐 노출	잔디꽃가루(grass pollen), 기타 꽃가루, 콩가루(soybean dust), 곰팡이 포자(fungal spores)
음식 알레르기	특정 음식 섭취 후 발생하는 알레르기 반응
야외 대기오염	오존, 질소산화물, 산성 물질, 미세 먼지등의 공기 오염
계절 변화	특히 가을철 개학 시기 등 특정 계절 변화 시기
흡입 스테로이드(ICS) 불충분 복용	천식 조절 약물을 지침대로 사용하지 않을 경우
대규모 천식 악화 유행 (Epidemic)	봄철 천둥번개 동반 폭풍(thunderstorms) 기간에 잔디꽃가루, 호밀꽃가루, 곰팡이 포자 등에 노출 시

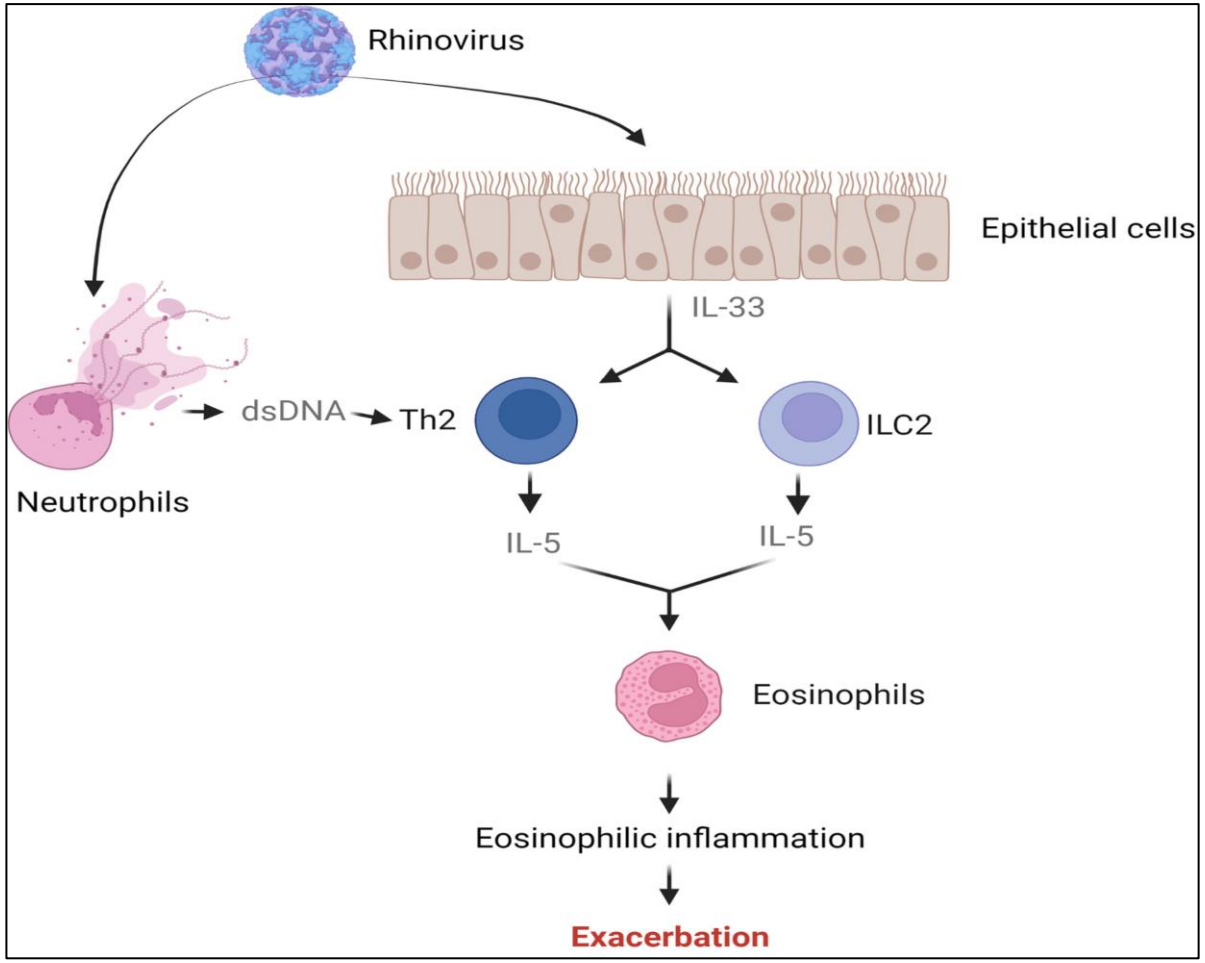




N Engl J Med 2017;377:965-976

Viral Infections Trigger Eosinophilic Asthma Exacerbations



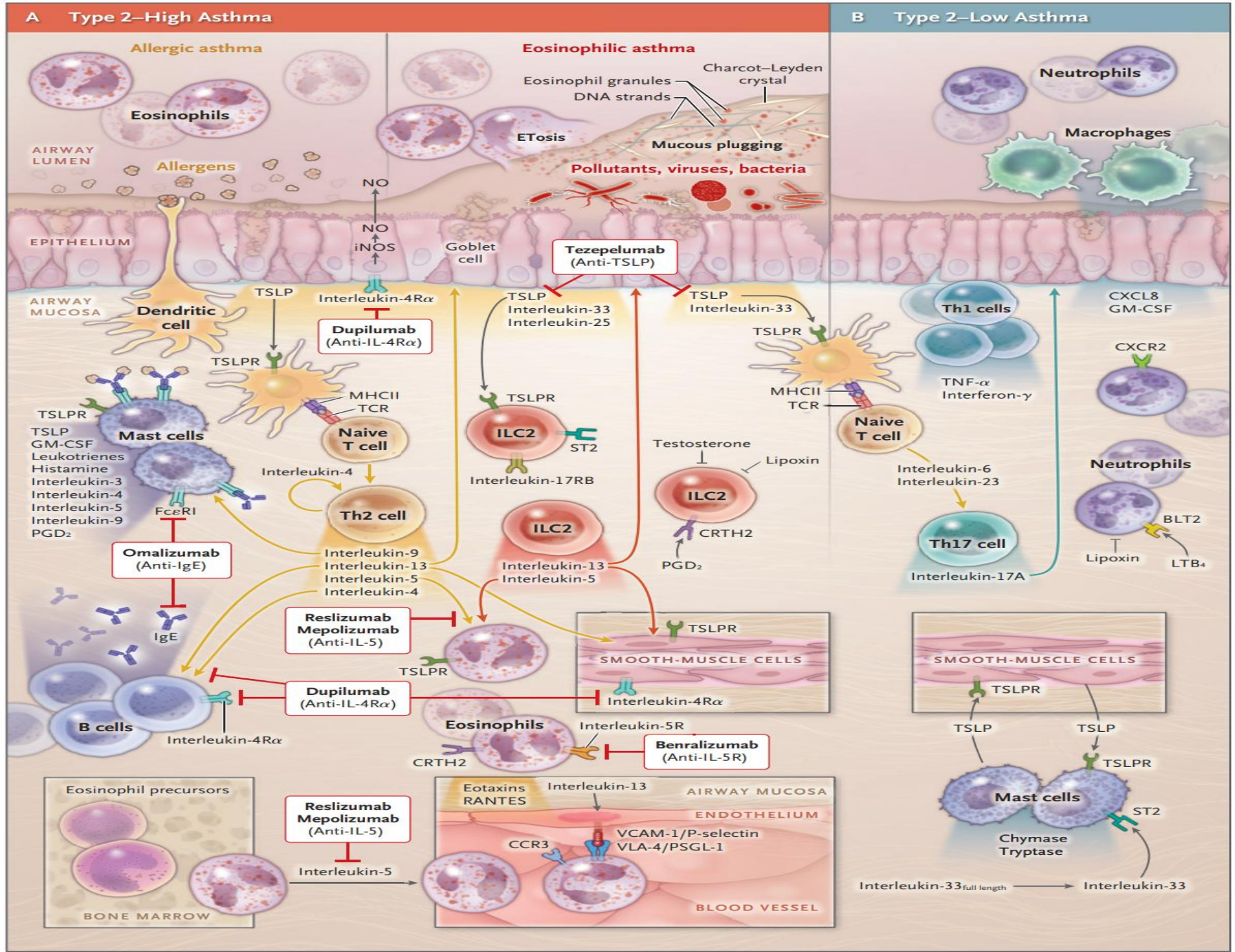


Trends Mol Med. 2022 Dec;28(12):1112-1127.

Vaccination in Asthma

백신 종류	천식 환자 대상 주요 권고 사항
COVID-19	• 최신 지침에 따라 **COVID-19** 백신 접종을 완료하도록 권고합니다.
인플루엔자 **(Influenza)**	• 특히 중등도-중증 천식 환자에게 **매년 접종**을 권고합니다.
호흡기 세포융합 바이러스 **(RSV)**	• **고령의 천식 환자(예: 60세 이상)**에게 **RSV** 백신 접종을 권고합니다.
폐렴구균 **(Pneumococcal)**	• 천식 환자(소아 및 성인)에게 폐렴구균 백신 접종을 권고합니다.
백일해 **(Pertussis)**	• 현지 예방접종 일정에 따라 백일해 백신 접종을 권고합니다.

GINA 2025



N Engl J Med 2022;386:157-71.

Table 2. FDA-approved biological therapies for severe asthma.

Biologic Therapies	Omalizumab	Mepolizumab	Benralizumab	Reslizumab	Dupilumab	Tezepelumab
Targets	IgE	IL-5	IL-5Rα	IL-5	IL-4Rα	TSLP
Related cell	T_{FH} cell	Th2 cell	Th2 cell	Th2 cell	Th2 cell	Epithelial cell
Molecular mechanisms	Blocks IgE-mediated immune stimulation	Prevents binding of IL-5 to IL-5Rα	Blockade of IL-5Rα ADCC-induced eosinophil apoptosis	Prevents binding of IL-5 to IL-5Rα	Dual receptor antagonism of IL-4/IL-13	Prevents TSLP binding to its receptor complex
Efficacy	Exacerbation ↓ FEV1 ↑ Quality of life and symptom control ↑	Exacerbation ↓ FEV1 ↑ Blood and sputum eosinophils ↓ Quality of life and symptom control ↑ OCS intake ↓	Exacerbation ↓ FEV1 ↑ Blood and sputum eosinophils ↓ Quality of life and symptom control ↑ OCS intake ↓	Exacerbation ↓ FEV1 ↑ Blood eosinophils ↓ Quality of life and symptom control ↑ OCS intake ↓	Exacerbation ↓ FEV1 ↑ OCS intake ↓	Exacerbation ↓ Blood eosinophils ↓ FeNO ↓
Approved ages	≥6 years old	≥6 years old	≥12 years old	≥18 years old	≥6 years old	≥12 years old
Route	Subcutaneous	Subcutaneous	Subcutaneous	Intravenous	Subcutaneous	Subcutaneous

천식 관련 사망 위험을 증가시키는 요인

1. 중증 천식 병력 **(History)**	**2.** 약물 사용 및 관리 **(Medication & Management)**	**3.** 동반 요인 **(Comorbidities)**
• 치명적 천식 병력 (기계환기 / 삽관 이력)	• 경구 스테로이드**(OCS)** 현재 사용 또는 최근 중단	• 정신질환 / 심리사회적 문제
• 최근 **1**년 내 천식으로 입원/응급실 방문	• 흡입 스테로이드**(ICS)** 미사용	• 식품 알레르기
	• **SABA** 과다 사용 (월 **1**캔 초과)	• 주요 동반질환 (폐렴, 당뇨병, 부정맥 등)
	• **ICS** 순응도 불량 또는 문서화된 천식행동계획 부재/미이행	

Managing modifiable risk factors (prevention of exacerbations)

GINA 2025 - personalized asthma management

REVIEW

- Symptoms
- Exacerbations
- Side-effects
- Comorbidities
- Lung function
- Consider biomarkers
- Patient (and parent/caregiver) satisfaction

ASSESS

- Confirmation of diagnosis if necessary
- Symptom control & modifiable risk factors
- Comorbidities
- Inhaler technique & adherence
- Patient (and parent/caregiver) preferences and goals

ADJUST

- Treatment of modifiable risk factors and comorbidities
- Non-pharmacological strategies
- Asthma medications including ICS
- Education & skills training, action plan

ICS: inhaled corticosteroids

Assessment of asthma control

Asthma control has **two** components

A. Recent asthma symptom control

B. Risk factors for poor asthma outcomes

- Exacerbations
- Persistent airflow limitation
- Medication side-effects

Box 2-2. GINA assessment of asthma control at clinical visits in adults, adolescents and children 6–11 years

A. Recent asthma symptom control (but also ask the patient/caregiver about the whole period since last review*)				
In the past 4 weeks, has the patient had:		**Well controlled**	**Partly controlled**	**Uncontrolled**
• Daytime asthma symptoms more than twice/week?	Yes☐ No☐	None of these	1–2 of these	3–4 of these
• Any night waking due to asthma?	Yes☐ No☐			
• SABA† reliever for symptoms more than twice/week?	Yes☐ No☐			
• Any activity limitation due to asthma?	Yes☐ No☐			

B. Risk factors for poor asthma outcomes
Assess risk factors at diagnosis and periodically, including after an exacerbation.
Measure FEV_1 at start of treatment, after 3–6 months of ICS-containing treatment to record the patient's personal best lung function, then periodically for ongoing risk assessment.
i. Risk factors for exacerbations
Uncontrolled asthma symptoms: Having uncontrolled symptoms is an important risk factor for exacerbations.
Factors that increase the risk of exacerbations even if the patient has few asthma symptoms:‡
SABA over-use: High SABA use (≥3 x 200-dose canisters/year associated with increased risk of exacerbations, increased mortality particularly if ≥1 canister per month)
Inadequate ICS: not prescribed ICS, poor adherence, or incorrect inhaler technique
Other medical conditions: Obesity, chronic rhinosinusitis, GERD, confirmed food allergy, pregnancy
Exposures: Smoking, e-cigarettes, allergen exposure if sensitized, air pollution
Psychosocial: Major psychological or socioeconomic problems
Lung function: Low FEV_1 (especially <60% predicted), high bronchodilator responsiveness
Type 2 inflammatory markers: Raised blood eosinophils, high FeNO (see biomarker overview)
Exacerbation history: Ever intubated or in intensive care unit for asthma, ≥1 severe exacerbation in last year
ii. Risk factors for developing persistent airflow limitation
History: Preterm birth, low birth weight and greater infant weight gain, frequent productive cough
Medications: Lack of ICS treatment in patient with history of severe exacerbation
Exposures: Tobacco smoke, noxious chemicals; occupational or domestic exposures
Investigation findings: Low initial FEV_1, sputum or blood eosinophilia
iii. Risk factors for medication side-effects
Systemic Frequent OCS, long-term, high-dose and/or potent ICS, P450 inhibitors§
Local: High-dose or potent ICS, poor inhaler technique

Asthma control: Risk factors for asthma exacerbations

Uncontrolled asthma symptoms increase the risk of exacerbations

Factors associated with increased exacerbation risk, even in patients with few symptoms:

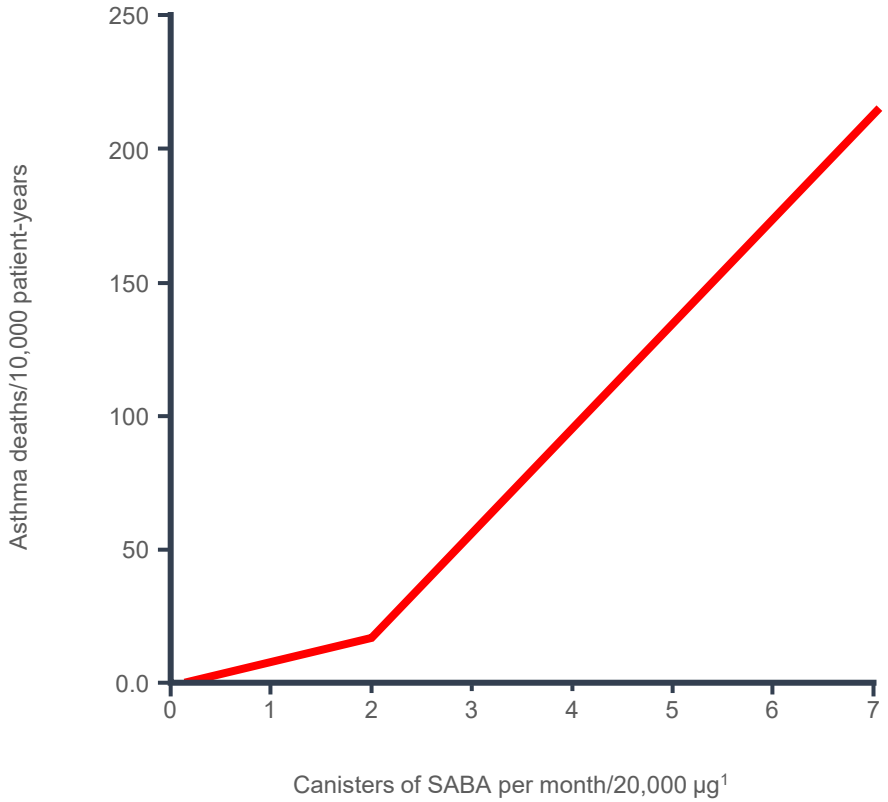
- SABA over-use, e.g., ≥3 canisters of salbutamol in 12 months (average daily use)
- Inadequate ICS (not prescribed, poor adherence, incorrect inhaler technique)
- Comorbidities (obesity, chronic rhinosinusitis, GERD, confirmed food allergy, pregnancy)
- Exposures (smoking, vaping, air pollution, allergen exposure if sensitized)
- Psychosocial or socioeconomic problems
- Low lung function
- High blood eosinophils or FeNO
- History of severe exacerbations

Supported by recent meta-analysis of data for many of these risk factors from the placebo arms of 22 clinical trials (ORACLE2 study, Meulmeester et al, Lancet Respir Med 2025)

People with infrequent symptoms can still have severe, life-threatening or fatal exacerbations

FeNO: fractional exhaled nitric oxide; GERD: gastro-esophageal reflux disease; ICS: inhaled corticosteroids; SABA: short-acting beta$_2$-agonist

Over-reliance on SABA increased risk of asthma related-death & exacerbation



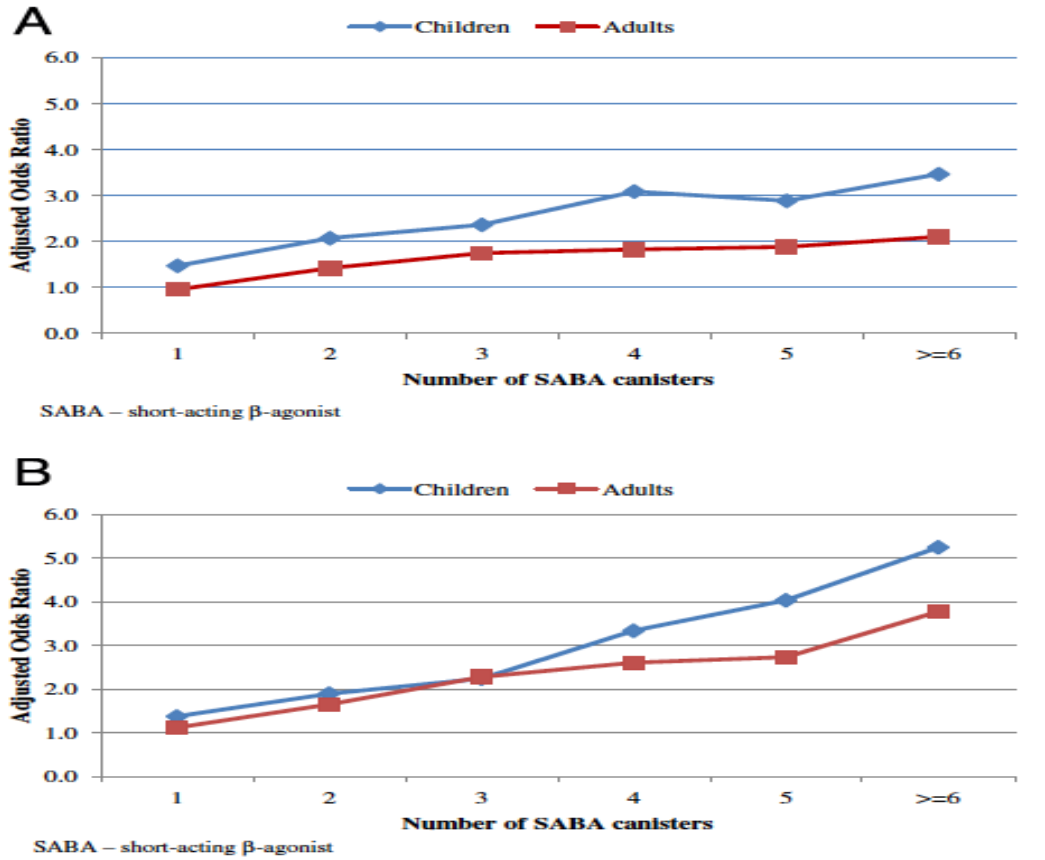


Fig. 1. *(A)* Odds of Asthma-related Hospitalization or emergency department visit by number of SABA canisters - Medicaid. *(B)* Odds of asthma-related hospitalization or emergency department visit by number of SABA canisters - Commercial.

[1]Am J Respir Crit Care Med. 1994 Mar;149(3 Pt 1):604-10.

[2]Ann Allergy Asthma Immunol. 2012 Dec;109(6):403-7

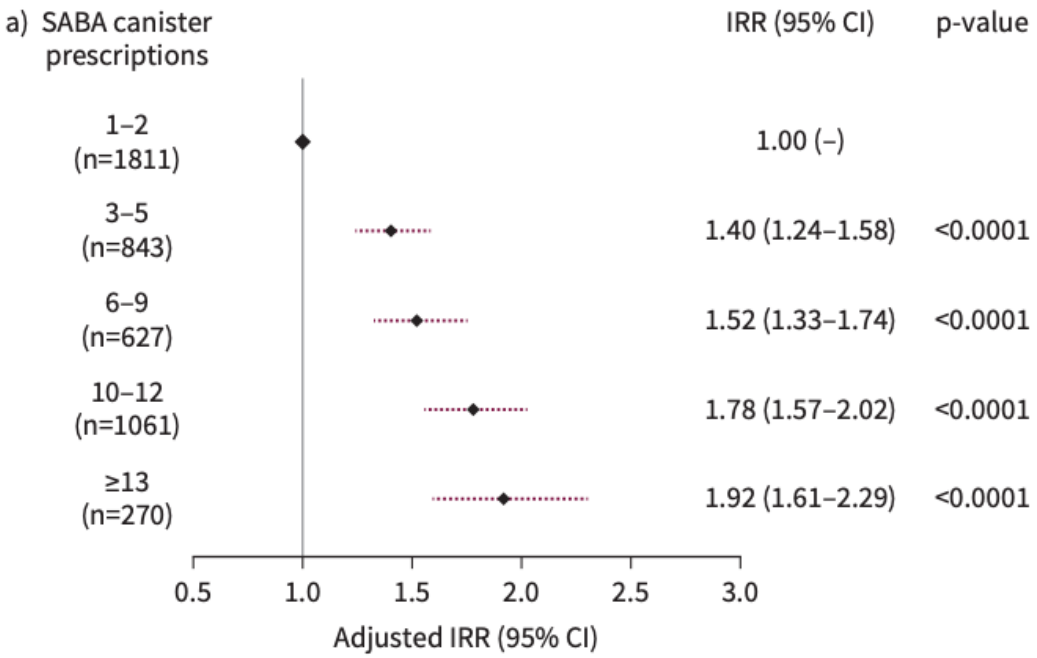
EUROPEAN RESPIRATORY JOURNAL
ORIGINAL RESEARCH ARTICLE
E.D. BATEMAN ET AL.

Short-acting β_2-agonist prescriptions are associated with poor clinical outcomes of asthma: the multi-country, cross-sectional SABINA III study

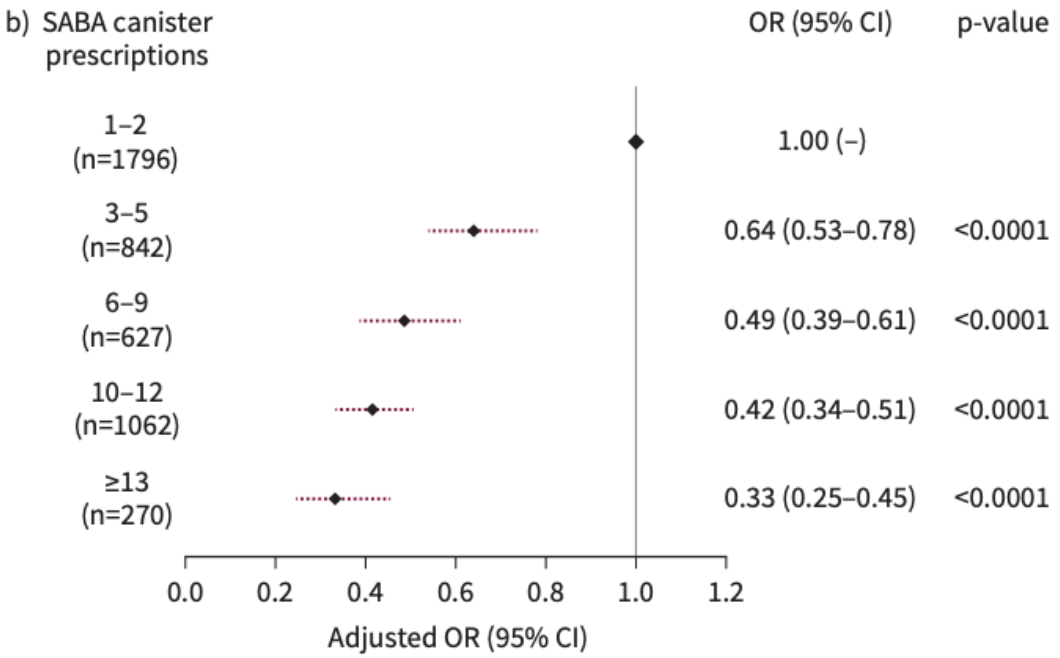
- SABINA III study design
  - multi-country, observational, cross-sectional study
  - 24 countries, 8351 patients recruited
  - employed electronic case report forms at a study visit (in primary or specialist care) to record prescribed medication(s), over-the-counter (OTC) SABA purchases and clinical outcomes in asthma patients (⩾12 years old) during the past 12 months. I

Eur Respir J. 2022 May 5;59(5):2101402.

Association of SABA prescriptions with severe exacerbations



Experiencing **a severe asthma exacerbation** by SABA canister prescriptions



Achieving **at least partly controlled asthma** according to SABA canister prescriptions

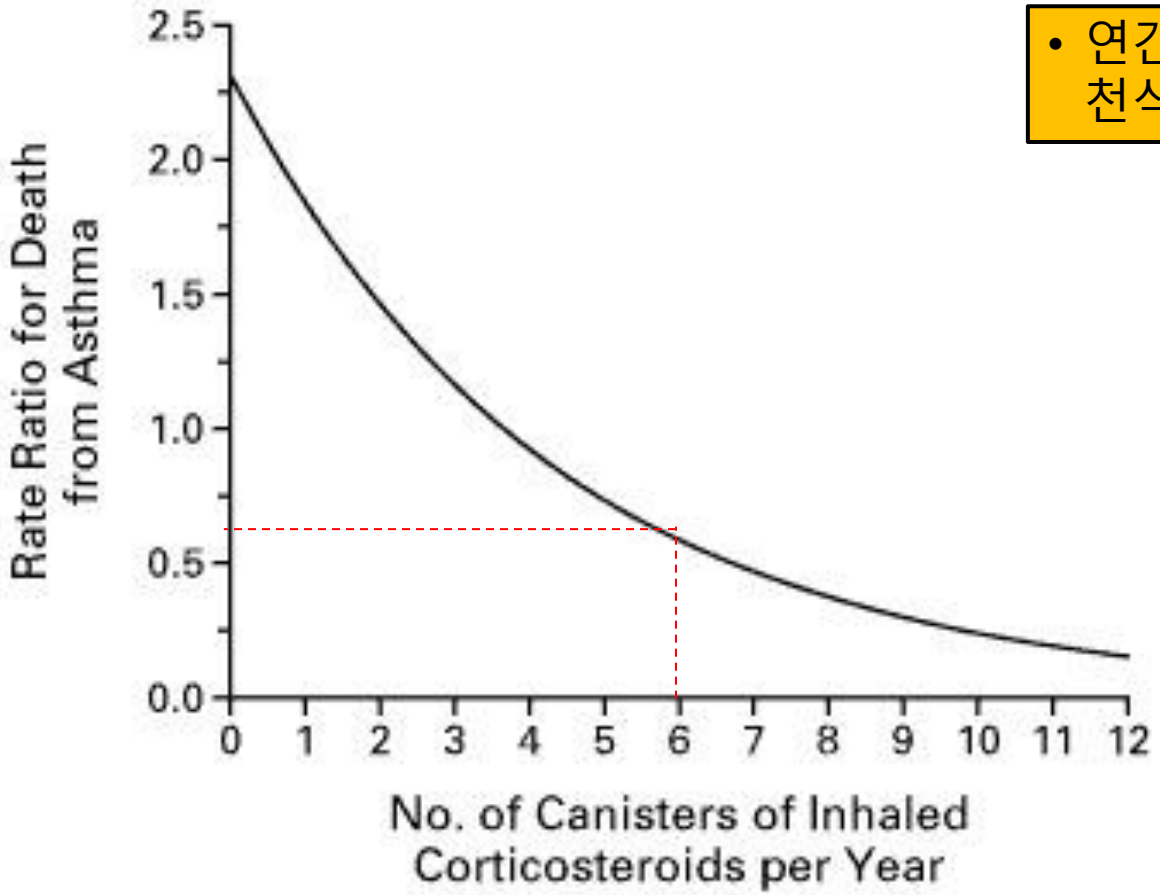
Why not treat with inhaled short-acting beta$_2$-agonists (SABA) alone?

- People with apparently mild asthma can have severe or fatal exacerbations *(Dusser et al, 2007)*
- Even 4–5 lifetime OCS courses increase the cumulative risk of adverse events including osteoporosis, diabetes, cataract, heart failure, pneumonia *(Price et al, J Asthma Allerg 2018)*
- Regular use of SABA for 1–2 weeks is associated with increased airway hyperresponsiveness, reduced bronchodilator effect, increased allergic response, increased eosinophils *(e.g. Cockcroft 2006)* → vicious cycle of increasing use
- SABA over-use is associated with ↑ exacerbations and ↑ mortality *(e.g. Suissa 1994, Nwaru 2020)*
- Starting treatment with SABA **trains** the patient to regard it as their primary asthma treatment
  - → Poor adherence with ICS is almost inevitable

There is strong evidence for a more effective and safer alternative: as-needed ICS-formoterol

ICS: inhaled corticosteroids; OCS: oral corticosteroids; SABA: short-acting beta$_2$-agonist

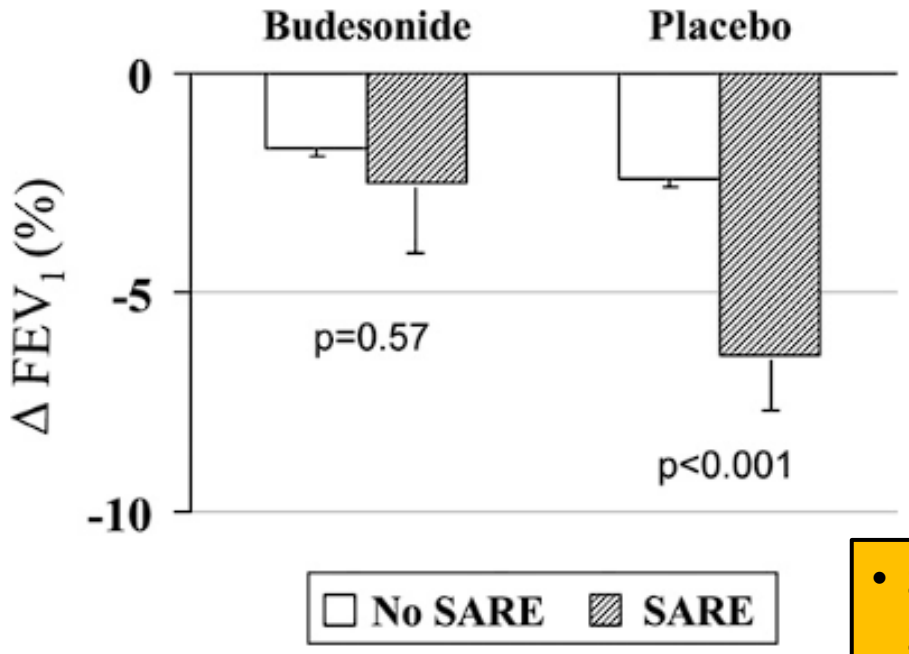
ICS is crucial for asthma treatment



- 연간 ICS 흡입기 사용 1개 증가시 천식 사망률은 21% 감소

N Engl J Med 2000; 343:332-336

Early ICS Therapy Protects Against Exacerbation-Related Loss of Lung Function



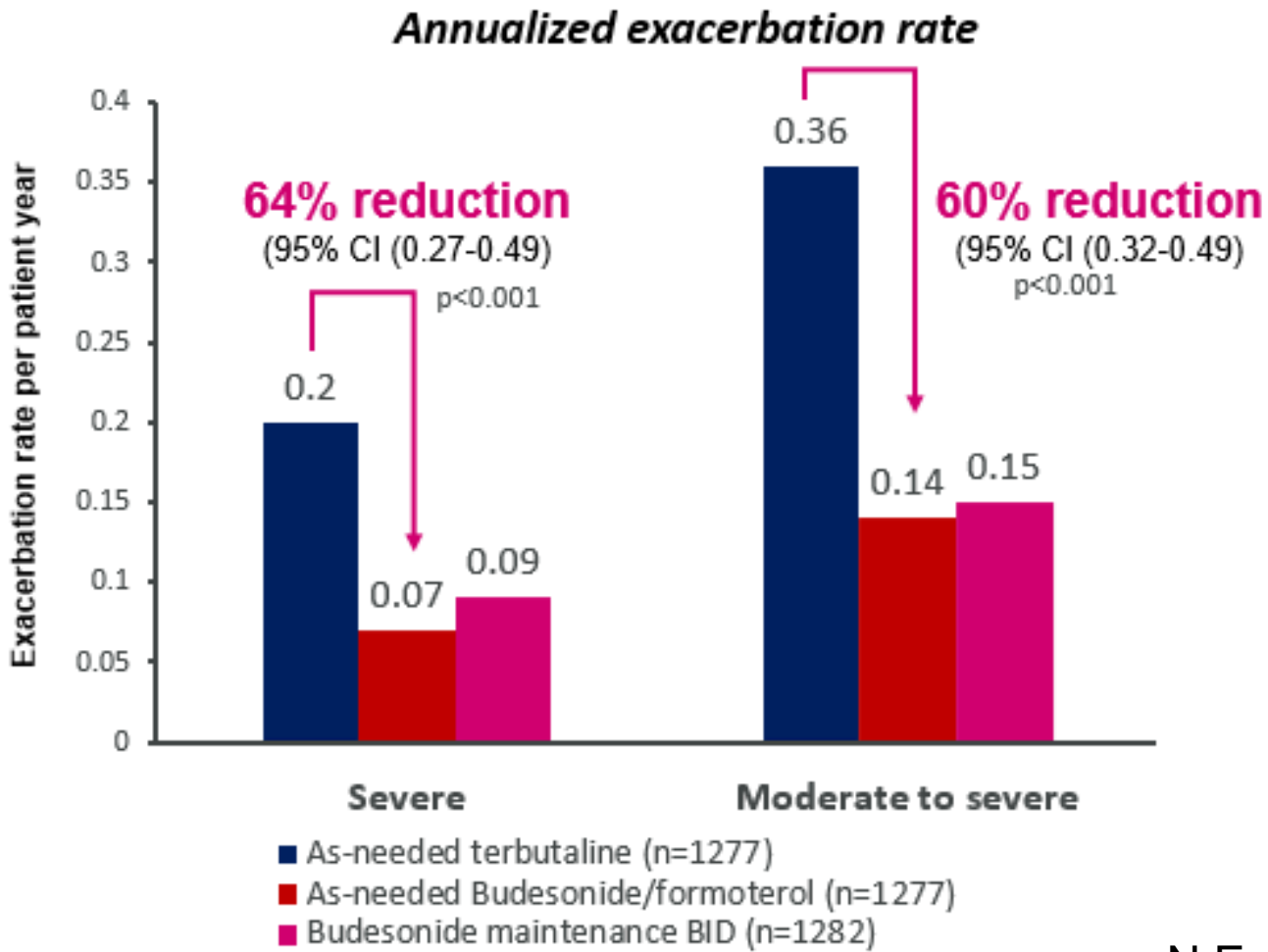
- **SARE**
  Severe **A**sthma-**R**elated **E**vent

Figure 2. Mean 3-year change, by mixed-model analysis, from baseline in post-bronchodilator FEV_1 % predicted for all patients treated with budesonide or placebo, with or without a SARE. Error bars indicate 1 SEM. *P* values refer to test of association between exacerbations and change in lung function.

Am J Respir Crit Care Med Vol 179. pp 19–24, 2009

Inhaled Combined Budesonide–Formoterol as Needed in Mild Asthma

Paul M. O'Byrne, M.B., J. Mark FitzGerald, M.D., Eric D. Bateman, M.D., Peter J. Barnes, M.D., Nanshan Zhong, Ph.D., Christina Keen, M.D., Carin Jorup, M.D., Rosa Lamarca, Ph.D., Stefan Ivanov, M.D., Ph.D., and Helen K. Reddel, M.B., B.S., Ph.D.



N Engl J Med 2018;378:1865-76.

Poor Inhaler Technique, Poor Asthma Control

Table 5 Percentage of observations of inhaler technique (yes = at least a critical error; no = no inhaler error) for the groups of asthmatic and COPD subjects according to some unscheduled health-care resources use in the last year.

Characteristic	COPD		Asthma		OR ± SE; P level[a,b]
At least a critical inhaler error	No	Yes	No	Yes	
Hospital admissions, %					
Never	62	55	86	76	1.47 ± 0.17; $p = 0.001$
1	23	26	9	13	
2–3	11	16	3	9	
>3	4	3	2	2	
Emergency department visits, %					
Never	71	64	81	69	1.62 ± 0.20; $p = 0.0006$
1	22	24	11	16	
2–3	4	10	3	10	
>3	3	2	4	5	
Antimicrobic courses, %					
Never	30	20	41	34	1.50 ± 0.15; $p = 0.00004$
1	29	31	30	25	
2–3	26	33	18	17	
>3	15	15	11	14	
Corticosteroid courses, %					
Never	37	29	35	27	1.54 ± 0.16; $p = 0.00003$
1	22	19	30	35	
2–3	30	26	22	19	
>3	11	26	13	19	

[a] Relationship between risk of at least a critical inhaler error and self-report of some unscheduled health-care resources use in the last year.
[b] Ordered logistic regression adjusted by diagnosis and type of inhaler and evaluated by $\chi 2$ for trend.

Respir Med. 2011 Jun;105(6):930-8.

Adherence to inhaled corticosteroids and clinical outcomes in mepolizumab therapy for severe asthma

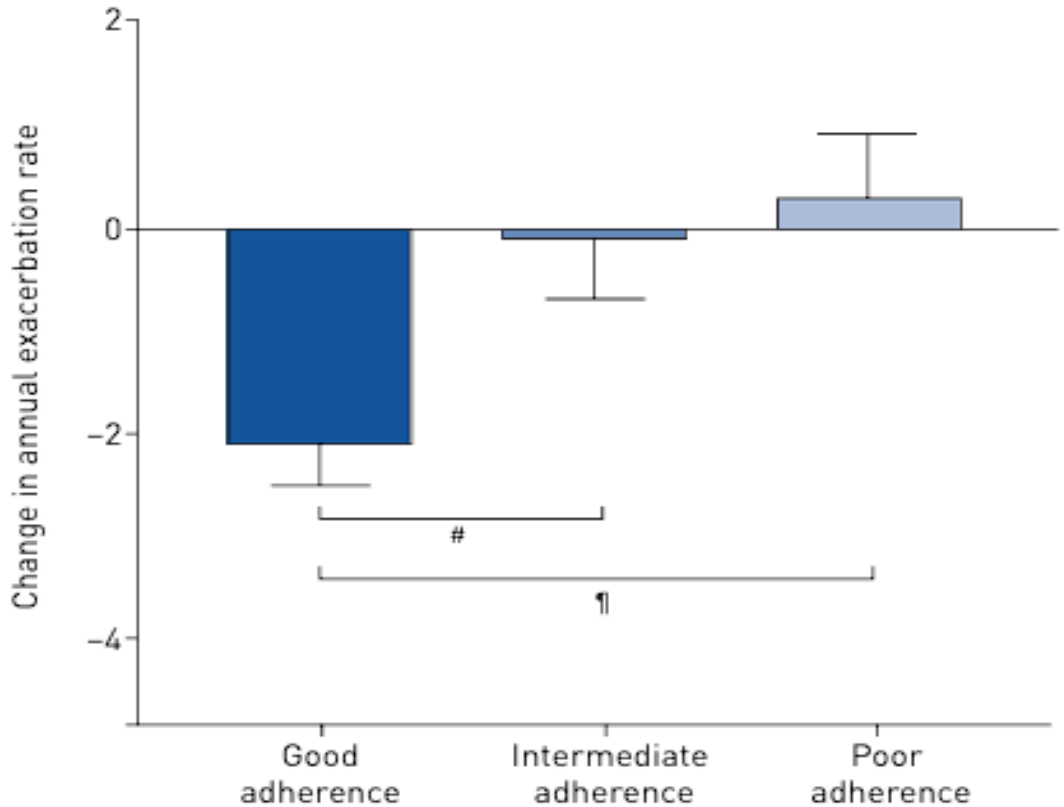
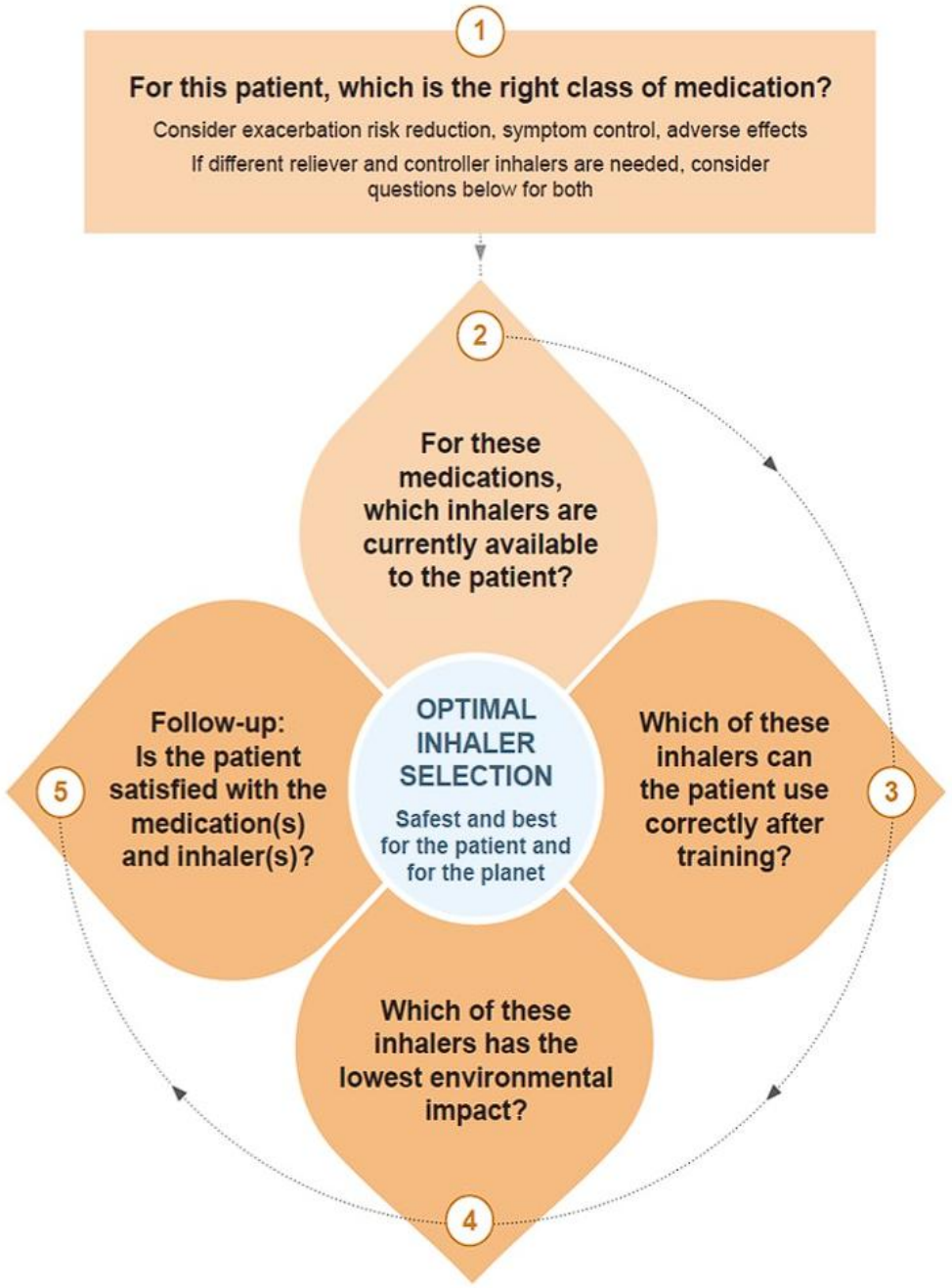


FIGURE 1 Changes in annual exacerbation rate on mepolizumab stratified by inhaled corticosteroid adherence. ANOVA p=0.004; #: p=0.065; ¶: p=0.011.

Eur Respir J 2020; 55: 1902259



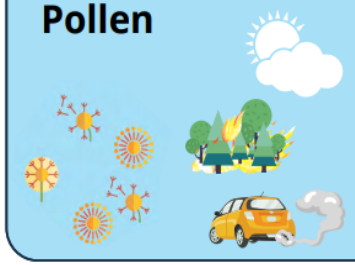
Box 5-3. Poor adherence to prescribed maintenance treatment in asthma

Factors contributing to poor adherence	How to identify poor adherence in clinical practice
Medication/regimen factors Difficulties using inhaler device (e.g., arthritis) Burdensome regimen (e.g., several times per day) Multiple different inhalers **Unintentional poor adherence** Misunderstanding about instructions Forgetfulness Absence of a daily routine Cost **Intentional poor adherence** Perception that treatment is not necessary Denial or anger about asthma or its treatment Inappropriate expectations Concerns about side-effects (real or perceived) Dissatisfaction with healthcare providers Stigmatization Cultural or religious issues Cost	For patients prescribed maintenance treatment, ask an empathic question Acknowledge the likelihood of incomplete adherence and encourage an open non-judgmental discussion. Examples are: '*Many patients don't use their inhaler as prescribed. In the last 4 weeks, how many days a week have you been taking it – not at all, 1, 2, 3 or more days a week?*'[511] '*Do you find it easier to remember your inhaler in the morning or the evening?*' Check medication usage: • Check the date of the last prescription. • Check the date and dose counter on the inhaler. • In some health systems, prescribing and dispensing frequency can be monitored electronically by clinicians and/or pharmacists. • See review articles for more detail.[197,512]

Examples of successful adherence interventions
Shared decision-making for medication/dose choice[200,203]
Inhaler reminders, either proactively or for missed doses[513-515]
Prescribing low-dose ICS once-daily versus twice-daily[516]
Home visits for a comprehensive asthma program by an asthma nurse[517]
Electronic monitoring of adherence with feedback to patients.[518]
In a systematic review, multidisciplinary care involving one-to-one advice and digitally enhanced communications appeared to offer the greatest benefit for improving adherence.[519]

Outdoor Triggers

Weather
Air Quality
Pollen

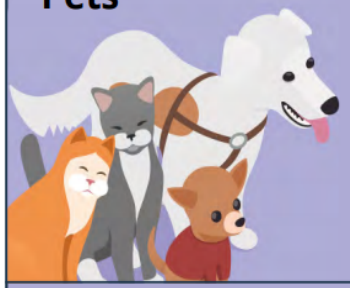


- Pay attention to radio, television, the internet, or newspaper reports about things that might trigger your asthma. These might include reports about weather, air quality, pollen count, or wildfire conditions.
- Plan outdoor activities for when the air quality is best.
- If pollen triggers your asthma, close windows and turn on air conditioning (if possible) when pollen levels are high.
- When there are wildfires, stay away from areas where there is smoke or vapors. Stay indoors, if possible, to avoid smoke or vapors.
- When it is cold, wear a scarf or face mask that covers your nose and mouth to keep airflow as warm as possible.

Indoor Triggers

If you are allergic to dust mites, cockroaches, rodents, indoor mold, or pets, use an air purifier with a high-energy particulate air (HEPA) filter, and use HEPA filters for vacuum cleaners. Keep your home as clean as possible. If you can, ask someone else to clean your home regularly, or wear a dust mask while you clean.

Pets



If you are allergic to your pet, the best way to avoid exposure is to remove the pet from your home and have the house cleaned. If you can't remove the pet:

- Keep the pet out of your bedroom.
- Ask a family member to wash your pet regularly.
- Use allergen-proof pillow and mattress covers.
- Use an air cleaner with HEPA filter.

Note: Pet fur, skin, and saliva trigger some people's asthma.

Dust mites
(tiny bugs that live in dust and fabric)

- Keep relative humidity levels in your home low, around 30%–50%.
- Wash your bedding every week and dry completely.
- Use allergen-proof pillow and mattress covers.

Indoor Triggers

Cockroaches
Mice
Rats

- Keep your kitchen clean and store food and garbage in closed containers.
- Don't leave out any standing water or other liquids.
- Seal cracks or openings in cabinets, walls, floorboards, and around plumbing.
- Use traps or poison bait to get rid of roaches, mice, or rats. Keep bait away and out of reach of children and pets. Avoid sprays and foggers.

Mold
Humidity

- Fix water leaks as soon as possible and dry damp or wet items within 48 hours.
- Remove all moldy items from your home.
- Use an air conditioner or dehumidifier to keep the air dry in your home. Keep relative humidity levels in your home low, around 30%–50%.
- Empty and clean refrigerator and air conditioner drip pans regularly.
- Use bathroom exhaust fans or open windows when you shower.

Smoke
Sprays
Scents
Disinfectants

- Avoid places where people smoke. If you smoke, ask your healthcare provider how to quit.
- Don't use a wood-burning stove, kerosene heater, or fireplace.
- Avoid perfume, paint, hairspray, and talcum powder.
- Try to stay away when cleaners or disinfectants are being used and right after their use.
- Increase air flow by opening doors and windows and turning on exhaust fans.

Other Common Triggers

Illness

- Contact your healthcare provider if you think you have another health problem that is making it harder for you to breathe. Such problems might include the flu, a cold, acid reflux (heartburn), a sinus infection, severe allergies, or another health concern.

Emotions

- Talk to your healthcare provider if anxiety, stress, or other emotions make your asthma worse.

Source: www.cdc.gov/asthma

표 4-2. 비약물 치료요법

비약물치료	조언/제안
금연과 담배연기 노출 환경 차단	- 진료 시마다 금연을 강력하게 권고하고, 상담과 금연 프로그램을 제공한다. - 천식 소아의 부모와 돌보미에게 금연을 권고하고, 방이나 이용 공간에서 흡연을 금지한다. - 담배연기의 환경적 노출을 피하도록 강력하게 권고한다. - 추가적 치료가 필요할 수 있으므로, 흡연 경험이 있는 경우 COPD나 ACO에 대해 평가한다.
신체 활동	- 규칙적인 운동을 권고한다. - 흡입스테로이드를 규칙적으로 사용하여 운동유발성 기도수축을 예방하도록 조언한다. - 운동 전 준비운동과 흡입속효성베타차단제나 저용량 흡입스테로이드-formoterol의 사용을 통해 돌발적 운동유발성 기도수축을 예방하도록 조언한다. - 규칙적 신체 활동은 심폐 건강을 증진시키며, 젊은 천식환자에서 수영등은 천식 조절 및 폐기능에 약간의 이점을 줄 수 있습니다. - 특정 신체 활동이 더 권장된다는 증거는 미약하다.
직업적 노출 회피	- 성인발생천식 환자는 직업력과 노출 환경을 조사한다. - 직업성천식 치료를 위해 직업성 감작물질을 가능한 빨리 발견하여 제거하고 더 이상 노출시키지 않게 한다. - 직업성천식이 의심되거나 확진된 환자는 평가와 조언을 위해 가능하다면 전문가에게 보낸다.
천식 악화 약제의 회피	- NSAID를 처방하기 전에 천식 유무를 항상 확인하고, 복용 후 천식이 악화되면 중단하도록 권고한다. - 동시에 투여되는 약제에 대해 환자에게 확인한다. - 이전에 아스피린과 NSAID에 의한 증상 악화가 없었다면, 일반적으로 사용의 금기는 아니다. - 경구 또는 점안용 베타차단제의 처방은 환자에 따라 결정하고, 전문가의 의학적 관리하에 투여를 시작한다. - 급성 관상동맥 질환으로 심장선택적 베타차단제가 필요한 경우 , 천식은 약제 사용의 절대 금기사항은 아니나 상대적인 위험과 이득을 고려하여 투여한다.
건강 식이	- 전반적 건강을 위해 과일과 채소 섭취를 권장한다.
실내 항원 회피	- 알레르기 항원 회피요법은 천식에서 일반적으로 권장되지는 않는다. - 감작된 환자에서 항원을 회피하기 위한 한가지 항원 회피 전략은 대부분 임상적 근거가 약하다. - 성인에서 집안의 습기와 곰팡이를 줄이는 것은 천식 증상 완화와 약물 사용량 감소 효과가 있다. - 집먼지 진드기와 동물에 감작된 환자에서, 회피 전략은 아이들을 제외하고는 임상적인 근거가 약하다. - 항원 회피는 보통 복잡하고 비싸며, 도움을 받을만한 대상자 선별에 대한 명확한 기준이 없다.
체중감량	- 비만 환자에게 체중 감량을 권장한다. - 성인 비만 환자의 경우 체중 감량 프로그램과 함께 주 2회 유산소 운동과 근력 운동을 병행하는 것이 체중 감량 단독 치료보다 천식 증상 조절에 효과적이다.
호흡법 교육	- 호흡 운동을 약물 요법에 추가하면 증상 완화 및 삶의 질 향상에 효과를 줄 수 있으나, 악화를 줄이거나 폐기능에는 영향을 주지 못한다.
실내공기 오염 회피	- 실내공기 오염을 발생시키지 않는 난방과 요리기구 사용, 그리고 환기시설을 잘 갖추도록 권고한다
실외 항원 회피	- 꽃가루와 곰팡이의 농도가 높을 때 창과 문을 닫고, 실내에서 공기 청정기를 사용하여 실외 항원으로부터 노출을 피한다.
감정적 스트레스 조절	- 감정적 스트레스가 천식을 더 악화시킨다면 이를 조절하는 전략을 세우고 환자를 격려한다. - 특정 스트레스 완화 전략이 더 낫다는 근거는 충분하지 않으나, 긴장완화요법과 호흡요법은 도움이 될 수 있다. - 불안감과 우울감이 있는 환자는 정신건강 상태를 평가한다.
실외공기 오염 회피	- 실외환경 온도가 매우 낮거나, 공기 오염이 심할 때 야외 운동을 피하고 실내에서 지내는 것은 도움이 될 수 있다. - 바이러스에 감염된 시기에는 오염된 환경을 피하는 것도 도움이 될 수 있다.
음식, 식품화학물질 회피	- 경구 유발검사를 통해 확인되지 않았다면 음식물 회피는 추천되지 않는다. - 음식 알레르기가 확인된 경우에는, 이를 회피하는 것이 천식 급성악화를 줄일 수 있다. - 식품화학물질에 대한 민감성이 있어도 일반적으로 철저한 회피는 필요하지 않으며, 천식조절이 호전됨에 따라 민감한 정도 또한 감소할 수 있다.

Box 3-7. Effectiveness of avoidance measures for indoor allergens

Allergen and avoidance measure	Degree of effectiveness (evidence level)	
	Reduction in allergen levels	Clinical benefit
House dust mites		
• Encase bedding in impermeable covers	Some (A)	Adults - none (A) Children - some (A)
• Wash bedding on hot cycle (55–60°C)	Some (C)	None (D)
• Replace carpets with hard flooring	Some (B)	None (D)
• Acaricides and/or tannic acid	Little (C)	None (D)
• Minimize objects that accumulate dust	None (D)	None (D)
• Vacuum cleaners with integral HEPA filter and double-thickness bags	Little (C)	None (D)
• Remove, hot wash, or freeze soft toys	None (D)	None
Pets		
• Remove cat/dog from the home	Little (C)	None (D)
• Keep pet from the main living areas/bedrooms	Little (C)	None (D)
• HEPA-filter air cleaners	Some (B)	None (A)
• Wash pet	Little (C)	None (D)
• Replace carpets with hard flooring	None (D)	None (D)
• Vacuum cleaners with integral HEPA filter and double-thickness bags	None (D)	None (D)
Cockroaches		
• Bait plus professional extermination of cockroaches	Minimal (D)	None (D)
• Baits placed in homes	Some (B)	Some (B)
Rodents		
• Integrated pest management strategies	Some (B)	Some (B)
Fungi		
• Remediation of dampness or mold in homes	A	A
• Air filters, air conditioning	Some (B)	None (D)

HEPA: high-efficiency particle air. This table is adapted from Custovic et al.[271]

Diagnosis of asthma exacerbations

Diagnosis of Exacerbations

- **A change in symptoms and lung function** from the patient's usual status
  - **Decrease in expiratory airflow** compared with previous lung function or predicted value
    - **Peak expiratory flow (PEF) or Forced expiratory volume in 1 second (FEV1)**
  - **The frequency of symptoms**

Type 2 biomarkers in the diagnosis and management of asthma

Biomarker	Typical criteria for 'high' in adults/adolescents	Factors affecting measurement
Blood eosinophil count (BEC)	For diagnosis of asthma: BEC ≥ upper limit of normal for the population from regional or national laboratory reference values. In severe asthma patients taking high-dose ICS: • BEC ≥150/μL suggests presence of Type 2 inflammation; • BEC ≥300/μL is a common threshold for eligibility for Type 2-targeted biologics.	BEC levels are influenced by multiple factors, including age, sex, time of day, smoking, and allergen exposure in sensitized individuals.[53,700] Within a population, BEC is higher: • in males than females • in the morning than the afternoon • in current smokers • with parasitic infections (e.g., helminths) • in allergic diseases (e.g., atopic dermatitis, allergic rhinitis, drug hypersensitivity) • with allergen exposure in sensitized individuals • in other non-asthma conditions (e.g., eosinophilic bronchitis, EGPA). Within a population, BEC is lower: • in some asthma phenotypes • in patients taking corticosteroids (particularly oral corticosteroids, but also inhaled and intranasal).
Fractional exhaled nitric oxide (FeNO)	Population reference values are not possible at present.[50] In the interim, the following levels are suggested as indicating high FeNO: • ICS-naïve: >50 ppb • Medium-dose ICS: ≥25 ppb • High-dose ICS: ≥20 ppb	FeNO levels are influenced by multiple factors, including age, sex, time of day, and by allergen exposure in sensitized individuals, as well as by measuring device and site.[50,313] Within a population, FeNO is higher: • in males than females • in the afternoon than the morning • in allergic diseases, e.g., atopic dermatitis, allergic rhinitis • approximately 24 hours after allergen exposure in sensitized individuals. Within a population, FeNO is lower: • in current smokers • during bronchoconstriction and with lower lung function • during the early allergic response • with inhaled corticosteroids (dose-dependent) but also with oral or nasal corticosteroids.

Clinical utility of Type 2 biomarkers

Biomarker	Clinical context or population	Clinical utility of biomarker
3. PROGNOSIS OF ASTHMA		
BEC	Patients with a history of ≥1 asthma exacerbation in the previous year	A high BEC is associated with a higher risk of (future) asthma exacerbations, particularly in patients taking a medium/high dose of ICS or OCS.[14,986,987]
FeNO	Patients with a history of ≥1 asthma exacerbation in the previous year	In ICS-treated patients, a high FeNO is associated with a higher risk of (future) asthma exacerbations.[14,986,987]
BEC and FeNO	Patients with a history of ≥1 asthma exacerbation in the previous year	BEC and FeNO provide complementary prognostic information in patients with asthma; risk of future asthma exacerbations is highest when both BEC and FeNO are high.[14]

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병력청취

- 악화가 시작된 시점과 원인
- 운동 능력의 제한이나 수면 장애를 포함한 천식 증상의 중증도 평가
- 아나필락시스를 의심할 만한 증상여부
- **천식 관련 사망인자의 존재여부**
- 현재 사용 중인 증상완화제와 조절제

신체진찰 및 객관적 검사

- **중증 발작의 징후와 활력 징후**(의식, 체온, 맥박수, 호흡 수, 혈압, 문장을 말할 수 있는 능력, 호흡 보조근 사용, 천명음 등)
- 악화 인자(아나필락시스, 폐렴, 기흉 등)
- 급성 호흡곤란을 일으킬 수 있는 다른 질환의 징후(심부전, 상기도 폐쇄, 이물질 흡입, 폐색전증 등)

객관적 평가

구분	주요 내용
폐기능 평가	• 가능하다면 **치료 시작 전 PEF 또는 FEV_1** 기록 • **치료 1시간 후** 및 일정 간격으로 추적 • 명확한 반응 또는 안정 시까지 모니터링
산소포화도 모니터링	• **SpO_2 <92%** → 입원 필요성 예측 인자 (**Evidence C**) • **SpO_2 <90%** → 적극적 치료 필요 시사 • 산소 공급 전·후 5분 이내 및 안정 시 재평가
ABGA	• **PEF 또는 FEV_1 <50% 예측치** • 초기 치료에 반응 없거나 악화되는 경우 • **PaO_2 <60 mmHg** 또는 **$PaCO_2$ ≥45 mmHg** → 호흡부전 지표
흉부 X선	• 고령자에서 동반 폐질환·심폐 합병증 의심 시 • 치료 반응 없으며 기흉·폐렴 가능성 있을 때

Assessing exacerbation severity

TABLE 3 Asthma exacerbation severity assessment criteria according to the Global Initiative for Asthma 2018[3]

Parameter	Exacerbation severity		
	Mild/moderate	Severe	Life-threatening
Dyspnea/body position	Sits upright	Sits hunched forwards	Sits hunched forwards
Speech	Talks in phrases	Talks in words	Talks in words
Level of consciousness	Normal	Agitated	Drowsy, confused
Respiratory rate	Increased but ≤30 breaths/min	>30 breaths/min	>30 breaths/min
Accessory muscles in use	No	Yes	Paradoxical breathing
Heart rate	100–120 bpm	>120 bpm	>120 bpm or bradycardia
PEF, % predicted	>50%	≤50%	optionally
SpO_2 (on air)	90%–95%	<90%	<90%

Abbreviations: PEF, peak expiratory flow; SpO_2, peripheral capillary oxygen saturation

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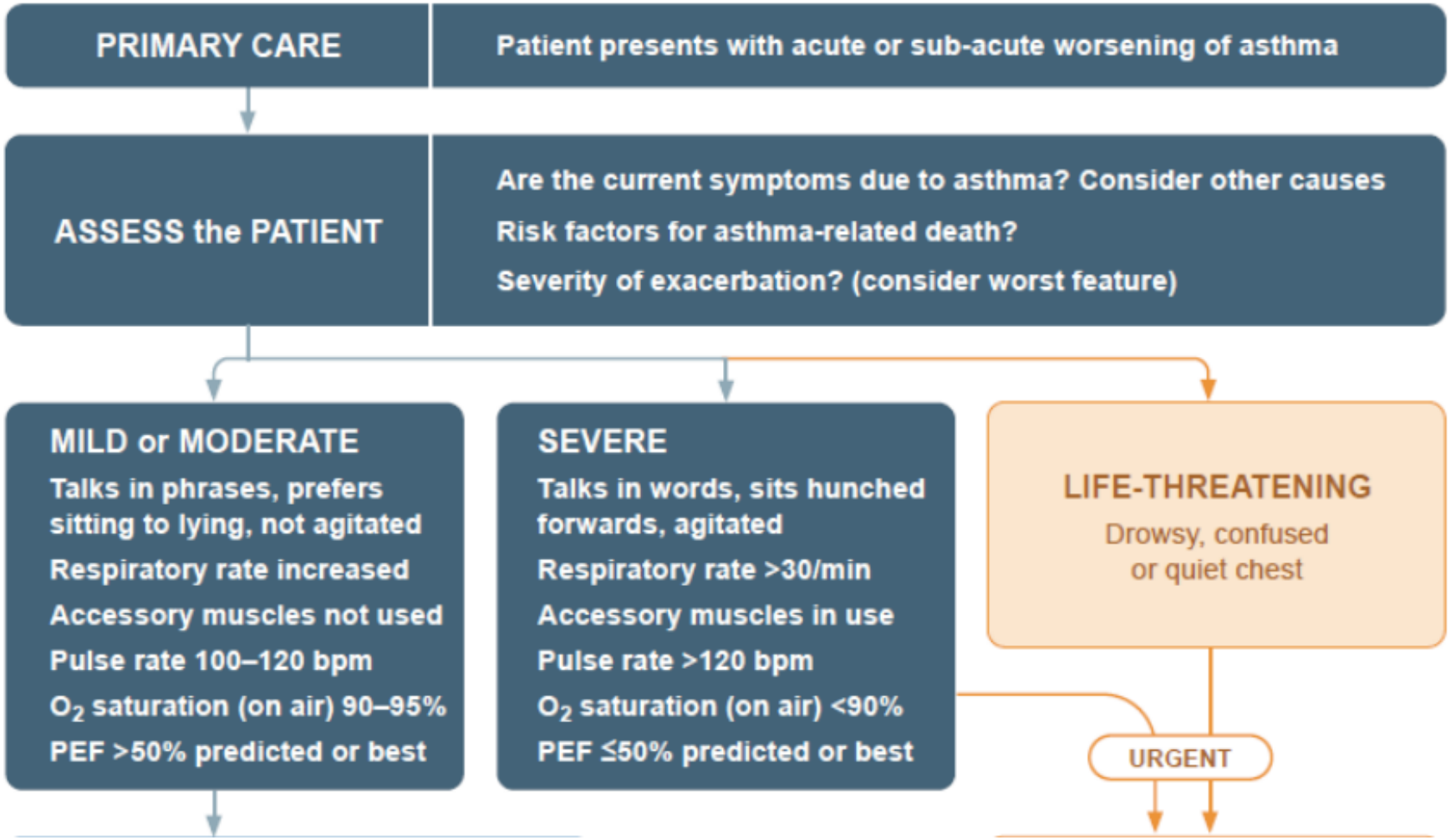
Management of Asthma exacerbations

1차 의료기관에서의 천식악화 치료



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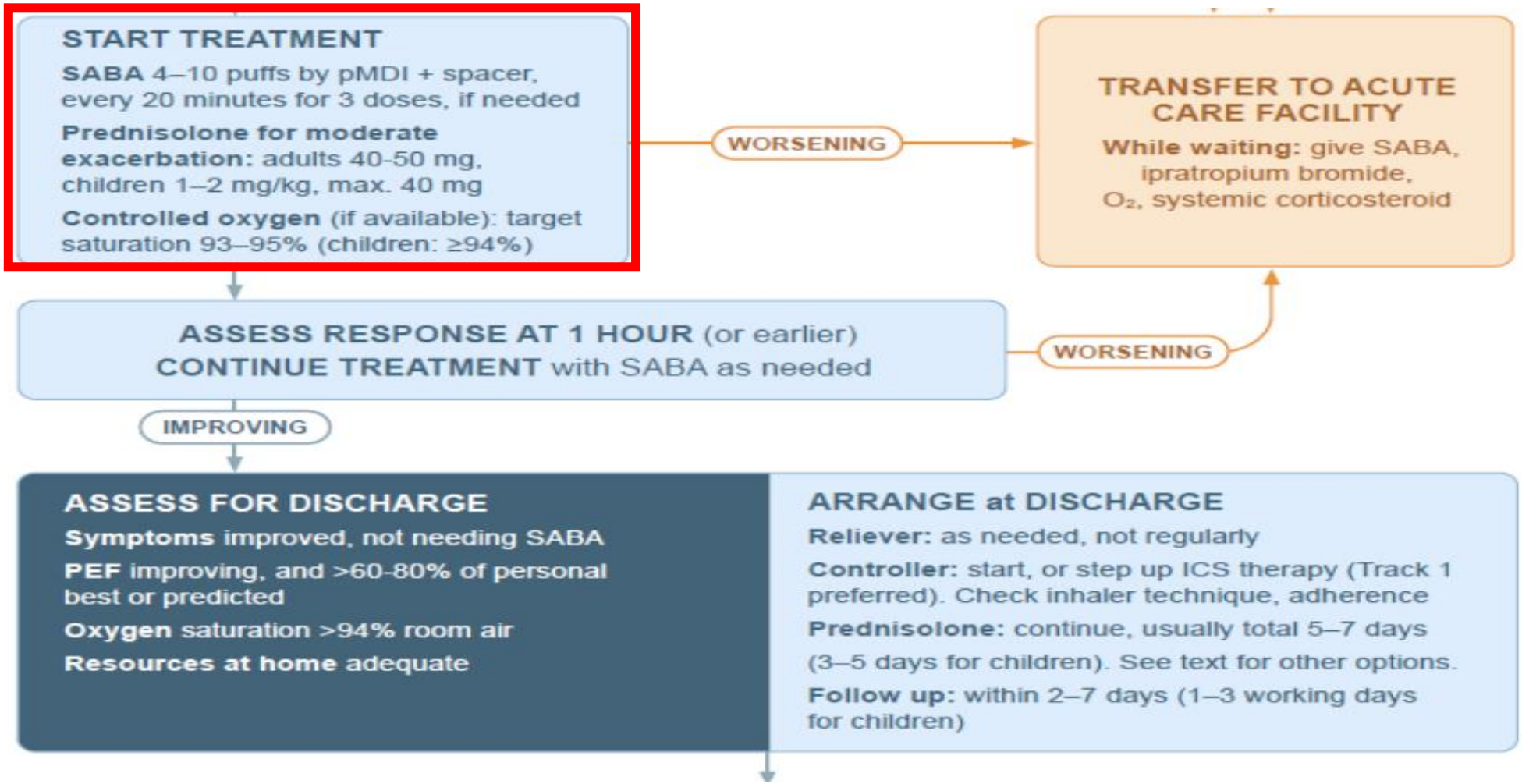
천식악화 치료의 기본 원칙

- 천식악화의 치료 목적
  - 신속히 기류 폐쇄 및 저산소혈증을 개선시키고, 염증성 병태생리의 조절, 재발을 예방하는 것
- 천식악화의 초기치료
  - 흡입속효성베타작용제의 반복 흡입
  - 전신적인 스테로이드의 조기 사용
  - 산소 투여

1차 의료기관에서의 천식악화 치료



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SABA

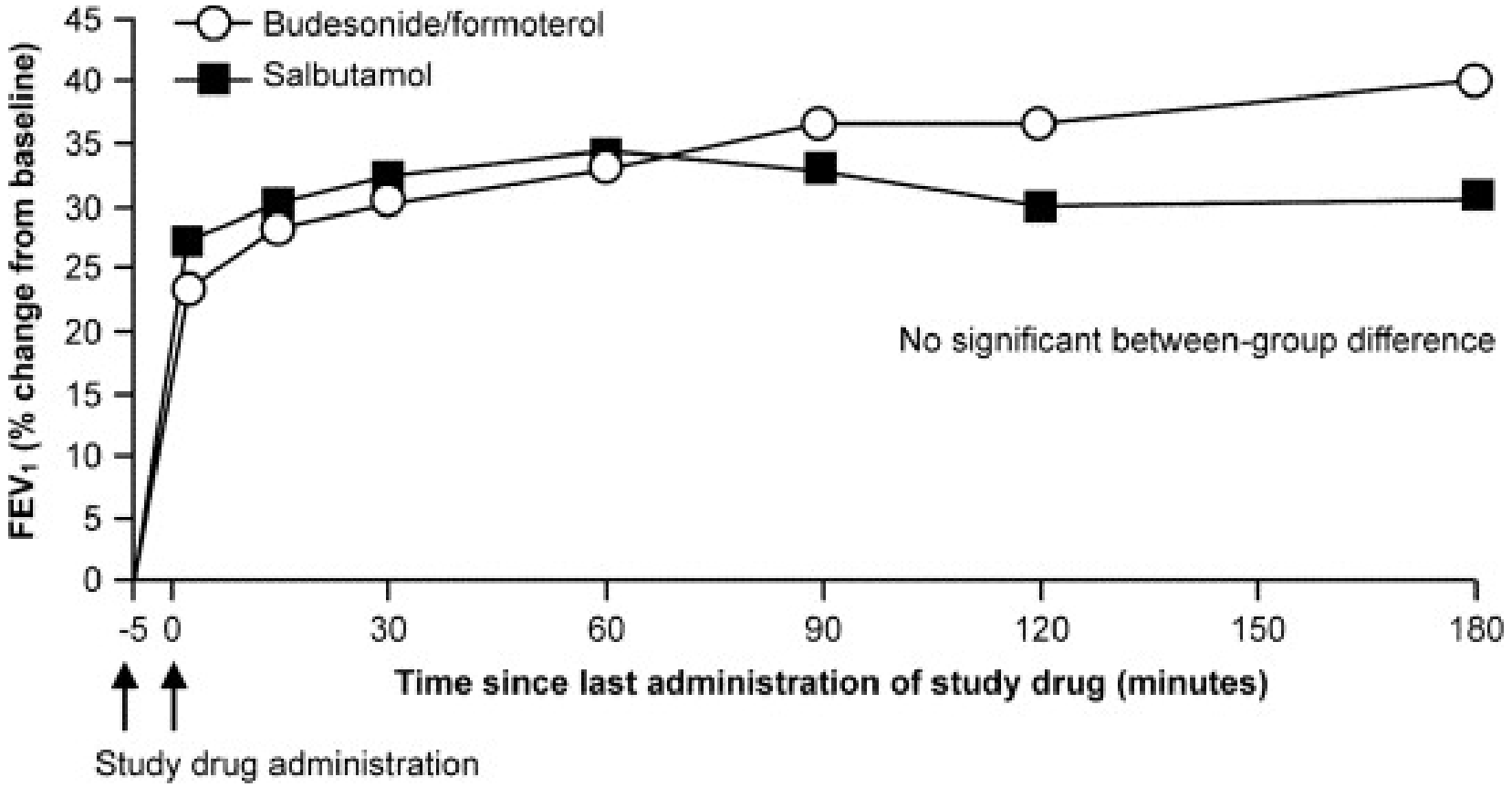
- 급성 악화의 **표준 치료제**: Salbutamol, albuterol
- 초기 1시간 동안 **SABA를 20분 간격으로 4-10회 흡입, 최대 3회**
- 초기 1시간 치료 후 PEF가 개인 최대치의 60-80%면 중단
- 증상지속시 경증시 3-4시간마다 4-10회 흡입 혹은
  중등증시 1-2시간마다 6-10회 흡입
- pMDI+Spacer는 네뷸라이저와 비슷한 효과
- IV 베타작용제는 권고하지 않음

ICS-formoterol

- budesonide-formoterol 200/6 μg (160/4.5 μg delivered dose) 기준, 24시간 내 **최대 12회 흡입**이 가능
- 일부 연구에서 천식악화시 SABA와 비슷한 효과와 안정성을 보여줬으나 급성 악화시의 ICS-formoterol의 사용에 대해서는 추가연구가 필요

Efficacy and safety of budesonide/formoterol compared with salbutamol in the treatment of acute asthma

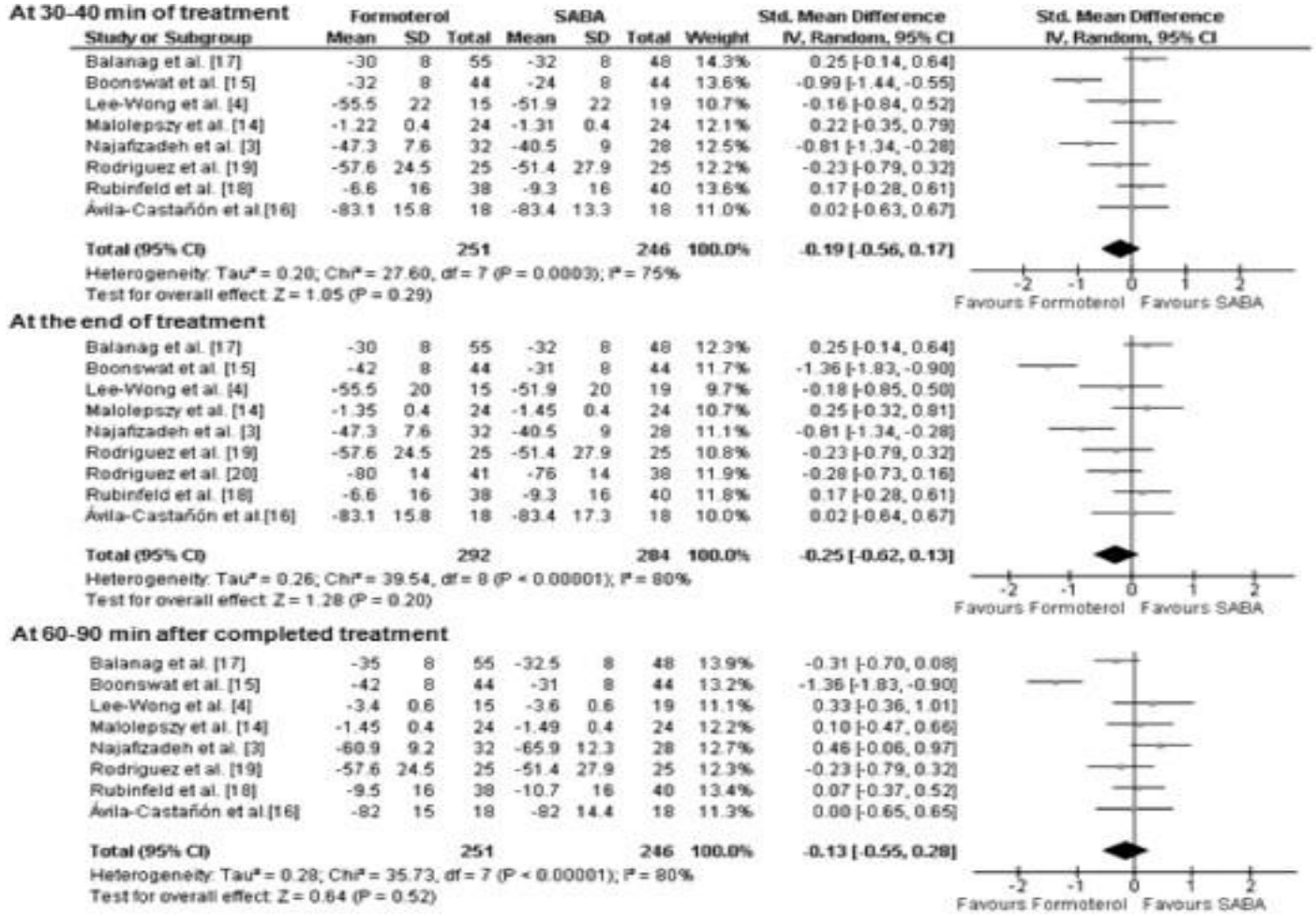
V.M. Balanag [a], F. Yunus [b], P.-C. Yang [c], C. Jorup [d]



Pulm Pharmacol Ther. 2006;19(2):139-47.

Formoterol for acute asthma in the emergency department: a systematic review with meta-analysis

Gustavo J. Rodrigo, MD*; Hugo Neffen, MD†; Federico D. Colodenco, MD‡; and José A. Castro-Rodriguez, MD, PhD§



Ann Allergy Asthma Immunol 2010; 104: 247-252.

Controlled oxygen therapy

- Target: SpO_2 93-95%

Table 2 The proportion of patients with a predetermined rise in the transcutaneous partial pressure of carbon dioxide ($Ptco_2$) from baseline at 60 min

	High concentration O_2 n (%)	Titrated O_2 n (%)	RR (95% CI)	p Value
Change in $Ptco_2$ ≥4 mm Hg	22 (44%)	10 (19%)	2.3 (1.2 to 4.4)	0.006
Change in $Ptco_2$ ≥4 mm Hg and $Ptco_2$ ≥38 mm Hg	17 (34%)	4 (8%)	4.5 (1.6 to 12.5)	0.001
Change in $Ptco_2$ ≥8 mm Hg	11 (22%)	3 (6%)	3.9 (1.2 to 13.1)	0.016

Thorax 2011;66:937-941.

Systemic corticosteroids

- Moderate or severe exacerbations 이거나 증상완화제와 질병조절제를 증량하여 사용함에도 악화가 지속되는 경우
  → 환자의 사망, 재발, 입원 및 증상완화제 사용을 줄여주므로 즉시 투여
- 권장용량 및 투여 기간
  - 성인 : **prednisolone 1mg/kg/day (최대 50mg/day) for 5-7days**
- 단기 및 장기 부작용에 유의
- OCS 사용 후에는 반드시 ICS 기반 유지치료를 최적화

GINA 2025

Duration of Systemic Corticosteroids in the Treatment of Asthma Exacerbation; a Randomized Study

Tsuyoshi HASEGAWA, Kyosuke ISHIHARA, Shunji TAKAKURA, Hiroshi FUJII, Takashi NISHIMURA, Miki OKAZAKI, Nobuyuki KATAKAMI and Bunichi UMEDA

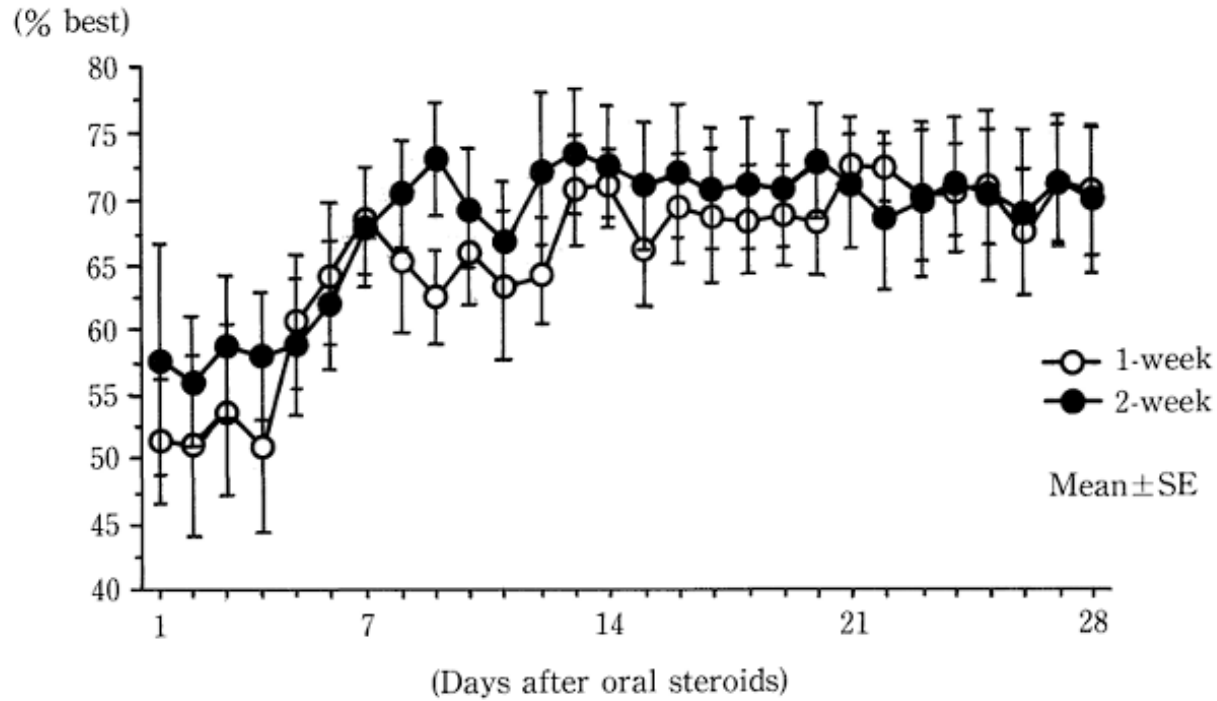


Figure 1. Changes over the course of time in PEF in the 1 week (○) and 2 week (●) course of oral prednisolone.

Intern Med 2000; 39: 794-797.

Prospective, placebo-controlled trial of 5 vs 10 days of oral prednisolone in acute adult asthma

A. M. Jones*, M. Munavvar*, A. Vail†, R. E. Aldridge*, L. Hopkinson*, C. Rayner* and B. R. O'Driscoll*

Table 2. Mean (SD) of individuals' mean PEF

Time	10-day group		5-day group		Group difference[a]	
	Open label	To day 21	Open label	To day 21	Mean (95% CI)	*P*-value
Waking	306 (79)	398 (103)	296 (82)	383 (90)	−6 (−47,36)	0.78
30 min[b]	355 (83)	435 (94)	341 (92)	415 (93)	−4 (−37,30)	0.83
Bedtime	357 (86)	427 (99)	348 (84)	405 (93)	−16 (−50,18)	0.35
Worst	273 (69)	389 (100)	277 (82)	371 (87)	−20 (−63,23)	0.36

[a]Estimated from analysis of covariance: negative difference implies lower (worse) mean value in 5-day group.
[b]PEF measured 30 min after morning dose of inhaled bronchodilator.

Respir Med 2002; 96: 950-954.

Double-blind trial of steroid tapering in acute asthma

B. R. O'DRISCOLL S. KALRA M. WILSON C. A. C. PICKERING
K. B. CARROLL A. A. WOODCOCK

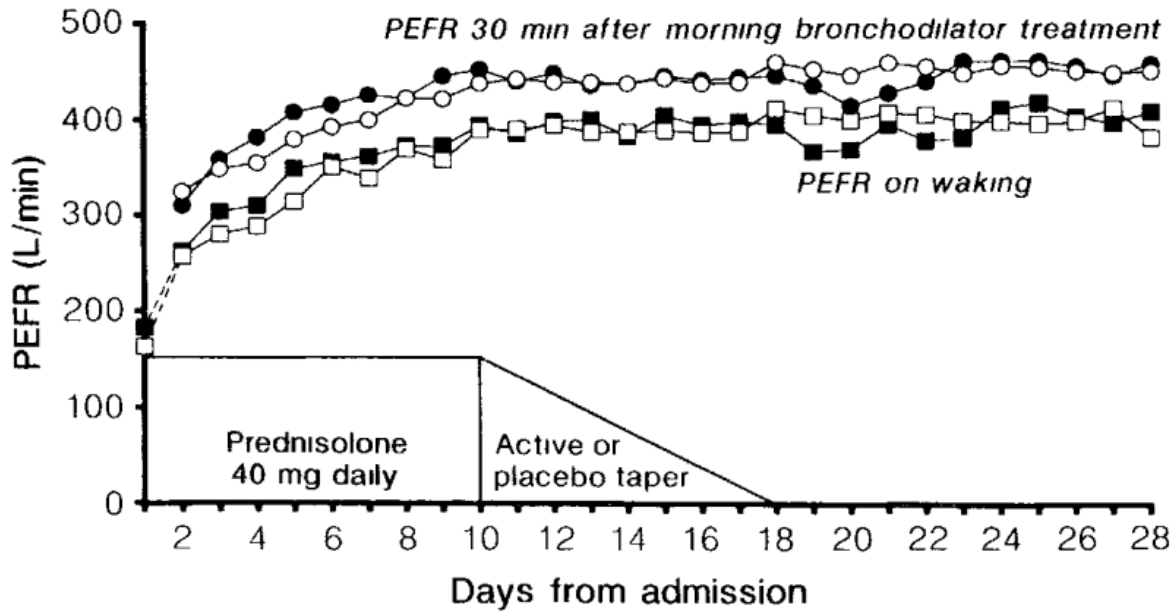
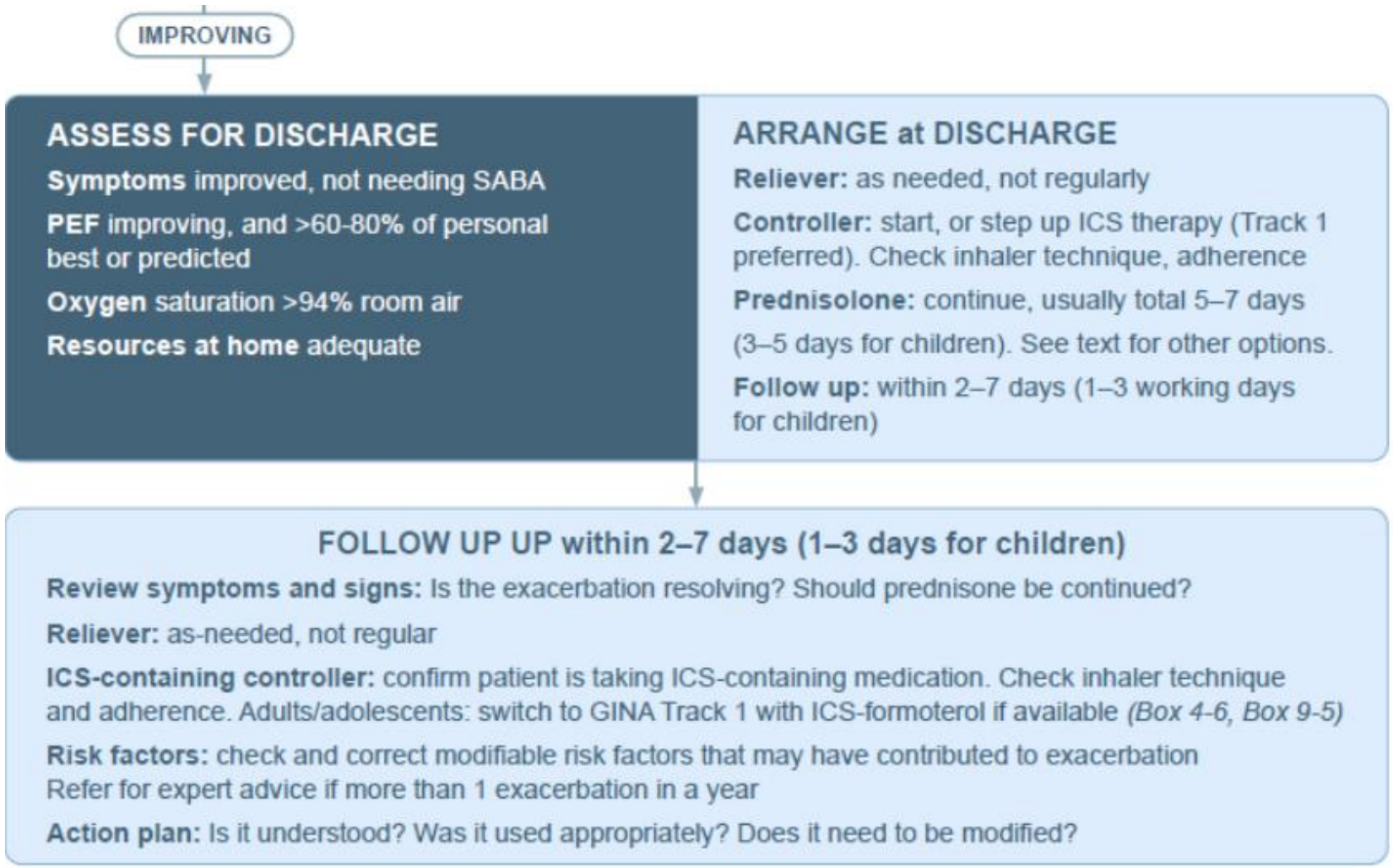


Fig 1—PEFRs during 28 days from day of admission (day 1).

Closed symbols = active taper group; open symbols = placebo taper group. Evening PEFR for both groups was almost identical to morning post-treatment PEFR (not shown). Repeated measures analysis of variance. PEFR on waking, active *vs* placebo p = 0·82; post-bronchodilator PEFR, active *vs* placebo p = 0·87.

Lancet. 1993 Feb 6;341(8841):324-7.

1차 의료기관에서의 천식악화 치료



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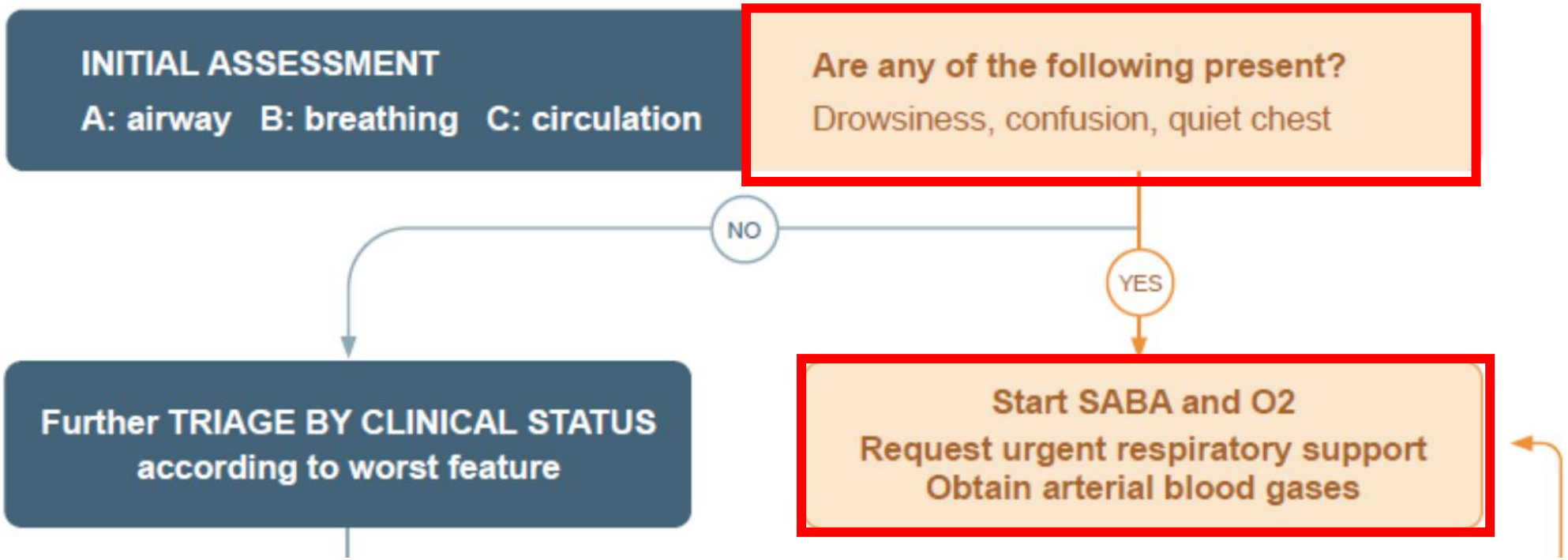
병원(응급실)에서의 천식의 급성악화 치료



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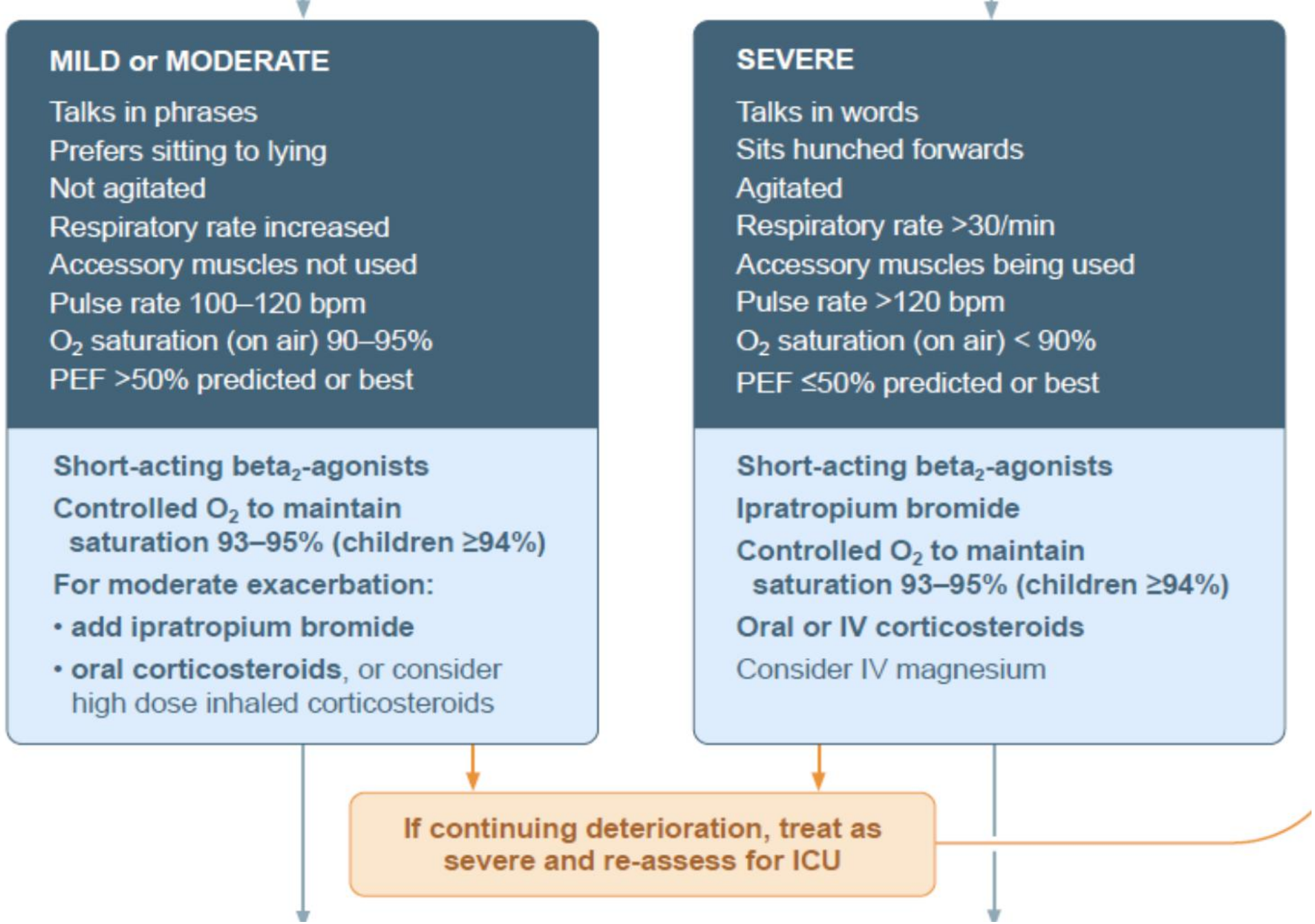

MILD or MODERATE
Talks in phrases
Prefers sitting to lying
Not agitated
Respiratory rate increased
Accessory muscles not used
Pulse rate 100–120 bpm
O2 saturation (on air) 90–95%
PEF >50% predicted or best
Short-acting beta2-agonists
Controlled O2 to maintain saturation 93–95% (children ≥94%)
For moderate exacerbation:
• add ipratropium bromide
• oral corticosteroids, or consider high dose inhaled corticosteroids
SEVERE
Talks in words
Sits hunched forwards
Agitated
Respiratory rate >30/min
Accessory muscles being used
Pulse rate >120 bpm
O2 saturation (on air) < 90%
PEF ≤50% predicted or best
Short-acting beta2-agonists
Ipratropium bromide
Controlled O2 to maintain saturation 93–95% (children ≥94%)
Oral or IV corticosteroids
Consider IV magnesium
If continuing deterioration, treat as severe and re-assess for ICU

GINA 2025

치료법	권고 사항	주요 근거 및 참고 사항
Ipratropium bromide	권고됨	중등도-중증 악화 시 **SABA**와 병용 시 입원율 감소, 폐 기능**(PEF/FEV1)** 개선 (근거 **A)**
Aminophylline & Theophylline	권고되지 않음	**SABA** 대비 효과가 낮고 안전성 프로파일이 좋지 않음. 부작용 (구역, 구토, 부정맥) 위험이 높으며, 추가 사용 시 이점 없음.
Magnesium	일상적 사용은 권고되지 않음	**초기치료에 반응하지 않고 저산소혈증이 지속되는 성인 및 소아** 내원시 FEV_1이 예측치의 25~30% 미만인 성인 정맥 주사**(2g IV over 20mins)**
Helium oxygen therapy	권고되지 않음 (근거 **B)**	표준 치료에 반응하지 않는 환자에게 고려될 수 있으나, 체계적 문헌 고찰 결과 일상적 사용을 뒷받침하지 못함.
LTRA	권고 근거 부족	급성 천식 악화 시 경구 또는 정맥 **LTRA** 사용에 대한 근거가 제한적임.
Antibiotics	권고되지 않음	**폐 감염(발열, 화농성 객담, 폐렴의 방사선 소견)의 명확한 증거**가 없는 한 권고되지 않음.
Non-invasive ventilation	권고 근거 약함	근거가 약하고 연구 규모가 작아 명확한 권고는 어려움.사용 시 면밀한 모니터링 필요 (근거 **D)**. 불안정한 환자에게 사용 금지.
Sedatives	절대 금기 (반드시 피해야 함)	호흡 억제 효과와 천식 사망과의 연관성 때문에 악화 시 엄격히 피해야 함 (근거 **D)**.

Treating eosinophilic exacerbations of asthma and COPD with benralizumab (ABRA): a double-blind, double-dummy, active placebo-controlled randomised trial

Sanjay Ramakrishnan, Richard E K Russell, Hafiz R Mahmood, Karolina Krassowska, James Melhorn, Christine Mwasuku, Ian D Pavord, Laura Bermejo-Sanchez, Imran Howell, Mahdi Mahdi, Stefan Peterson, Thomas Bengtsson, Mona Bafadhel

- **대상자**: 급성 악화 시점의 천식 또는 COPD 환자, 혈중 호산구 ≥300/μL. 총 158명
- 무작위 배정 (1:1:1)
  - **PRED group**: prednisolone 30 mg/day ×5일 +위약주사
  - **BENRA group**: benralizumab 100 mg SC 1회 + 위약정
  - **BENRA+PRED group**: benralizumab + prednisolone 병용
- **Co-primary outcomes:**
  - 90일 내 **치료 실패율** (재치료, 입원, 사망 포함)
  - 28일째 **증상 VAS 점수 변화**

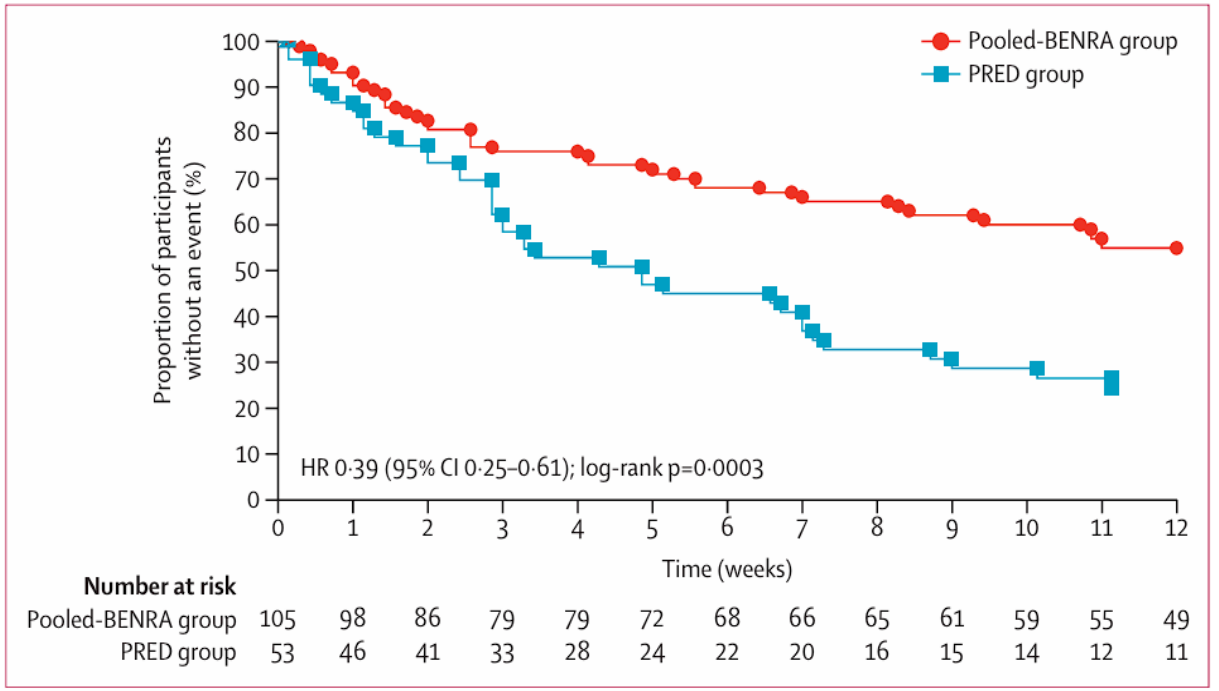


Figure 2: **Kaplan–Meier plot of time to first treatment failure event in the PRED and pooled-BENRA treatment groups**
The PRED group indicates the prednisolone only group (blue line). The pooled-BENRA group indicates the benralizumab alone and the benralizumab plus prednisolone groups pooled together (red line).

Lancet Respir Med 2025; 13: 59–68

	PRED group (n=53)	Pooled-BENRA group (n=105)	p value
Number of patients with treatment failure at 90 days	39 (74%)	47 (45%)	..
Odds ratio (95%CI) *vs* PRED group	..	0·26 (0·13 to 0·56)	0·0005
Change in total VAS symptoms from exacerbation to day 28			
Mean change (95% CI) in mm	103 (75 to 132)	152 (131 to 173)	..
Least-square mean difference *vs* PRED group	..	49 (14 to 84)	0·0065
Change in total VAS cough from exacerbation to day 28			
Mean change (95% CI) in mm	23 (16 to 30)	34 (28 to 39)	..
Least-square mean difference *vs* PRED group	..	10 (2 to 19)	0·020
Change in total VAS dyspnoea from exacerbation to day 28			
Mean change (95% CI) in mm	27 (19 to 34)	34 (28 to 39)	..
Least-square mean difference *vs* PRED group	..	7 (−2 to 16)	0·133
Change in total VAS wheeze from exacerbation to day 28			
Mean change (95% CI) in mm	23 (16 to 29)	36 (32 to 41)	..
Least-square mean difference *vs* PRED group	..	14 (6 to 22)	<0·001
Change in total VAS sputum purulence from exacerbation to day 28			
Mean change (95% CI) in mm	13 (7 to 18)	24 (20 to 28)	..
Least-square mean difference *vs* PRED group	..	11 (4 to 18)	0·002
Change in total VAS sputum volume from exacerbation to day 28			
Mean change (95% CI) in mm	17 (11 to 23)	26 (21 to 30)	..
Least-square mean difference *vs* PRED group	..	9 (2 to 17)	0·016

The VAS was measured on a 100 mm scale for which 0 indicated the best symptoms and 100 indicated the worst symptoms. For VAS the minimal clinical important difference is 9. All analyses were adjusted for randomisation stratification factors namely diagnostic label, steady state FEV_1 predicted, number of exacerbations in the previous year, and smoking status. The PRED group indicates the prednisolone only group. The pooled-BENRA group indicates the benralizumab alone and the benralizumab plus prednisolone groups pooled together.

Table 2: **Primary endpoint for the PRED and the pooled-BENRA treatment groups**

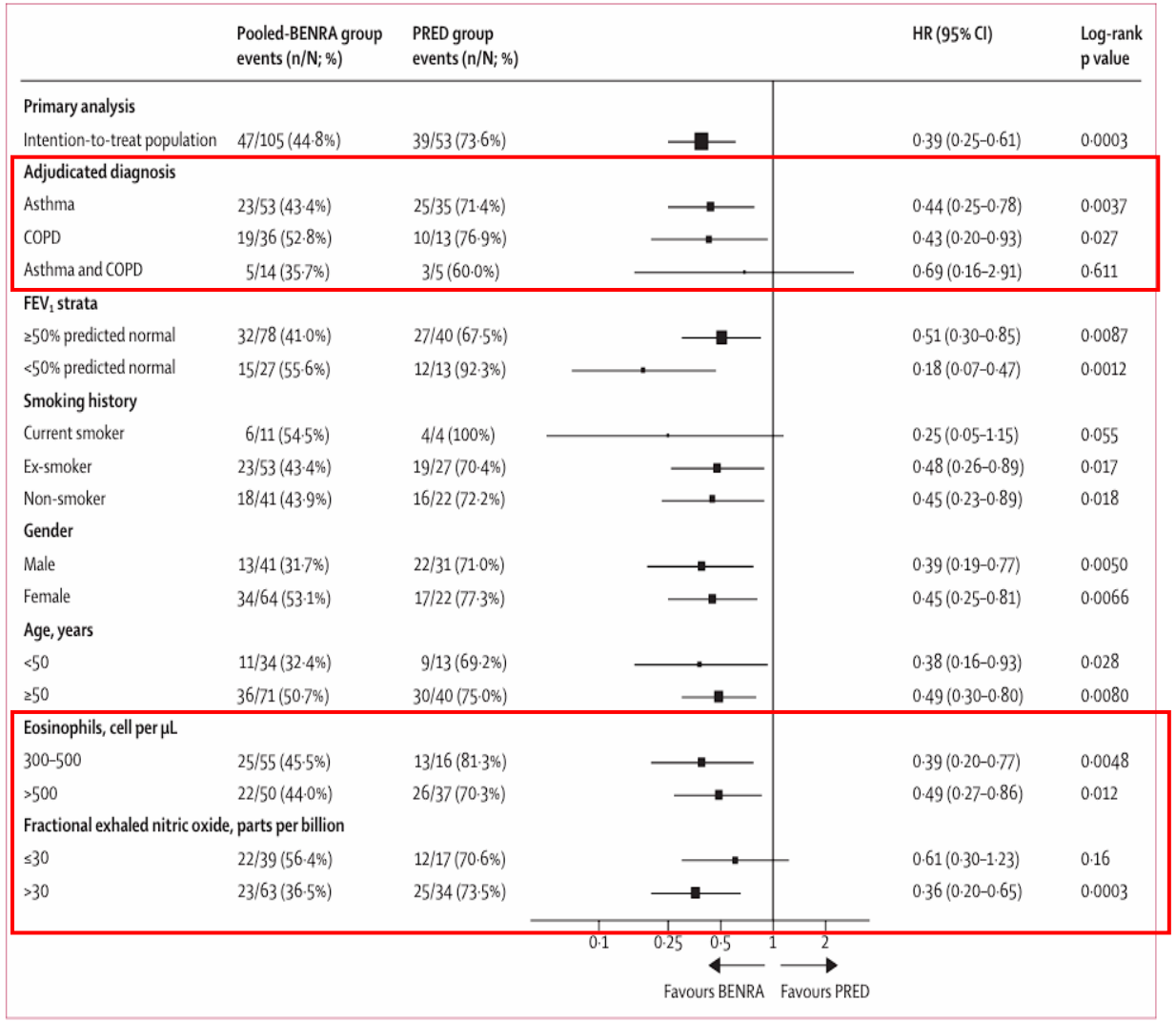


Figure 3: **Post-hoc sub-group analysis for time to treatment failure in the PRED and pooled-BENRA study treatment groups**
Data are presented according to diagnosis, steady state lung function, smoking history, sex, age, and exacerbation biomarkers (eosinophils and fractional exhaled nitric oxide). The PRED group indicates the prednisolone only group. The pooled-BENRA group indicates the benralizumab alone and the benralizumab plus prednisolone groups pooled together.

Lancet Respir Med 2025; 13: 59–68



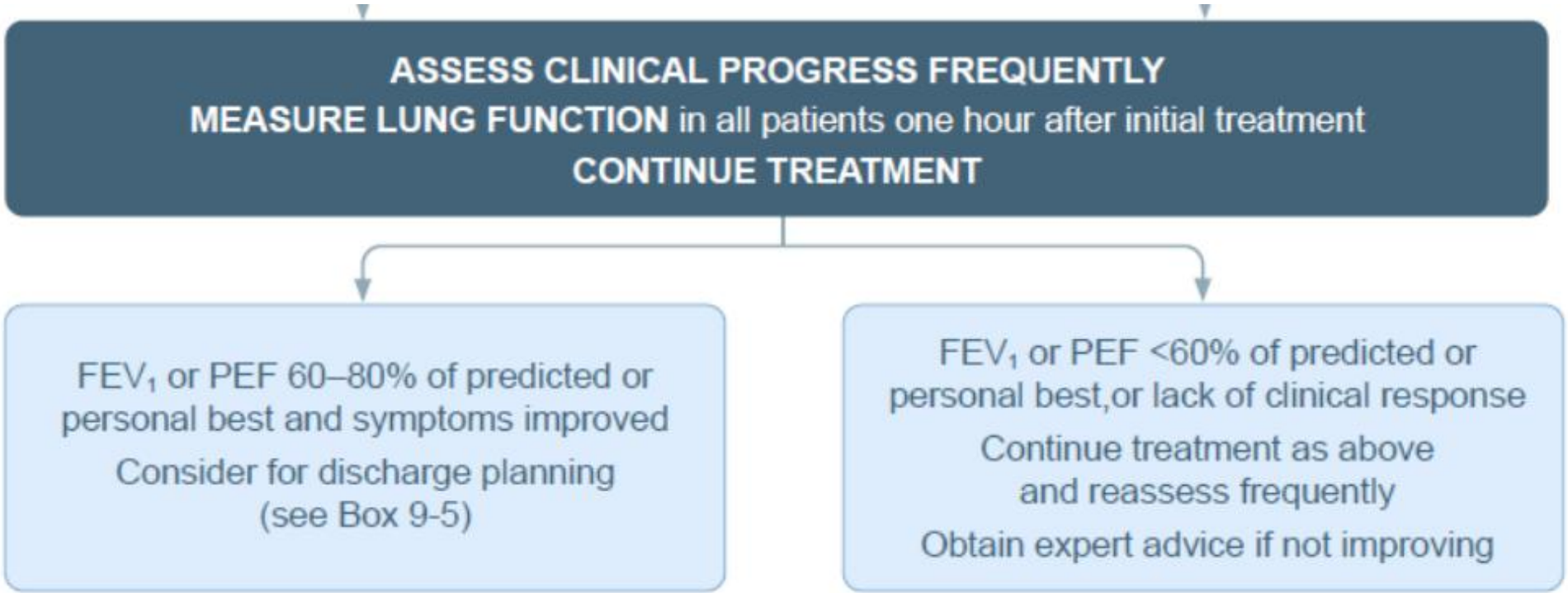


	Supplemental O_2	HFNT	NIV	IMV	VV ECMO
Indications	Spo_2 < 92% in asthma Spo_2 < 88% in COPD	Severe dyspnea with respiratory distress (eg, accessory muscle use) Persistent hypoxemia despite O_2	Severe dyspnea with respiratory distress Persistent hypoxemia despite O_2 $PaCO_2$ ≥ 45 mmHg and pH ≤ 7.35	Cardiac arrest/HD instability Inability to tolerate NIV or worsening respiratory failure despite NIV Altered consciousness Massive aspiration or persistent vomiting	Hypercapnic respiratory failure (pH < 7.25) despite optimal IMV Hypoxemic respiratory failure despite optimal IMV Hemodynamic compromise from hyperinflation
Initial Settings	Titrate 1-15 L/min flow to target Spo_2 93%-95% in asthma and Spo_2 88%-92% in COPD	Flow 15-60 L/min; use higher flow to obtain a PEEP of 3-5 cm H_2O Titrate FIO_2 to target Spo_2 93%-95% in asthma and Spo_2 88%-92% in COPD	Titrate PS to target V_T of 6-8 mL/kg IBW Initial PEEP approximately 5 cm H_2O Titrate FIO_2 to target Spo_2 93%-95% in asthma and Spo_2 88%-92% in COPD	V_T 6-8 mL/kg RR, 10-12 breaths/min PEEP, 0-10 cm H_2O Titrate FIO_2 to Spo_2 goal I:E ratio between 1:2 and 1:4 Flow rate, 60-100 L/min Trigger sensitivity, −1 to −2 cm H_2O or 2 L/min[a]	Titrate 2-6 L/min flow to Spo_2 goal Titrate FDO_2 to Spo_2 goal Sweep 1-9 L/min, titrate to reduce $PaCO_2$ by < 20 mmHg in first 24 h
Complications	Hyperoxia associated with increased mortality in COPD Epistaxis	Claustrophobia/ discomfort Impaired swallow function and risk of aspiration	Claustrophobia/discomfort Skin breakdown at mask interface Gastric distention/risk of aspiration	Barotrauma (eg, pneumothorax) Ventilator-associated pneumonia ETT complications (eg, tracheal stenosis) Muscle weakness	Hemorrhage Thrombosis Infection Cannulation complications (eg, vascular perforation)

Figure 2 – *Diagram outlining the indications, initial settings, and complications of the various respiratory support methods that can be used during a severe asthma or COPD exacerbation.*[11,12,43,112-115,128,143,150,159,172-175] [a]*Trigger sensitivity should be set to −1 to −2 cm H_2O with pressure triggering or 2*

CHEST Critical Care 2025; 3(1):100107

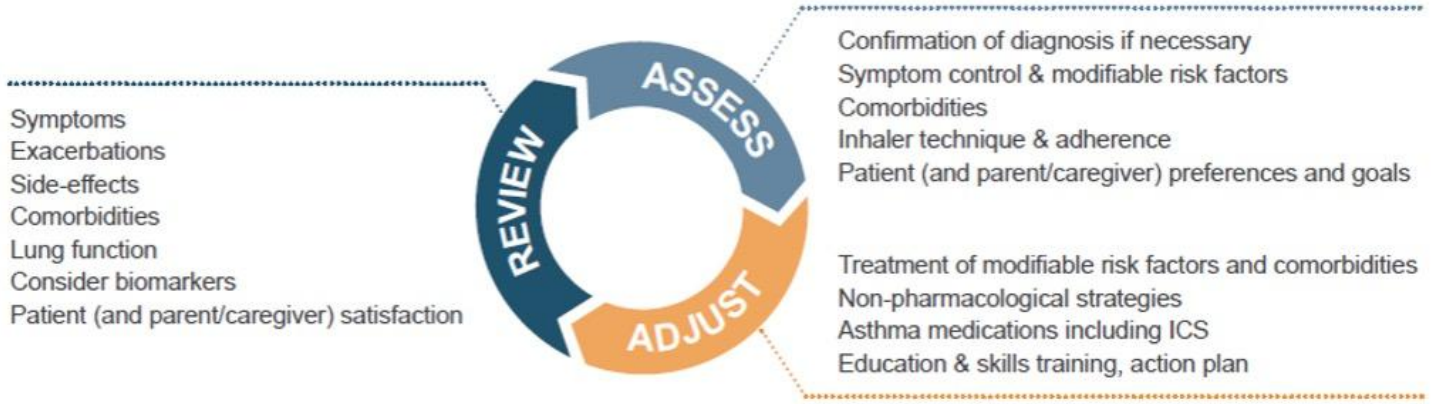
병원(응급실)에서의 천식의 급성악화 치료



GINA 2025

GINA 2025
Adults & adolescents 12+ years

Personalized asthma management
Assess, Adjust, Review
for individual patient needs



TRACK 1: PREFERRED CONTROLLER and RELIEVER
Using ICS-formoterol as the reliever* reduces the risk of exacerbations compared with using a SABA reliever, and is a simpler regimen

STEPS 1 – 2
AIR-only*: low-dose ICS-formoterol as needed

STEP 3
MART* with low-dose maintenance ICS-formoterol

STEP 4
MART* with medium-dose maintenance ICS-formoterol

STEP 5
Add-on LAMA
Refer for assessment of phenotype. Consider trial of high-dose maintenance ICS-formoterol. Consider anti-IgE, anti-IL5/5R, anti-IL4Rα, anti-TSLP

RELIEVER: As-needed low-dose ICS-formoterol*

See GINA severe asthma guide

TRACK 2: Alternative **CONTROLLER and RELIEVER**
Before considering a regimen with SABA reliever, check if the patient is likely to adhere to daily controller treatment

STEP 1
Reliever only; if SABA, take ICS with each dose

STEP 2
Low dose maintenance ICS

STEP 3
Low dose maintenance ICS-LABA

STEP 4
Medium dose maintenance ICS-LABA

STEP 5
Add-on LAMA
Refer for assessment of phenotype. Consider trial of high-dose maintenance ICS-LABA. Consider anti-IgE, anti-IL5/5R, anti-IL4Rα, anti-TSLP

RELIEVER: as-needed ICS-SABA*, or as-needed SABA

Non-pharmacologic strategies include smoking cessation, physical activity, pulmonary rehabilitation, weight reduction, vaccinations (see text for more)
Allergen immunotherapy, e.g. HDM SLIT: consider for patients with clinically relevant sensitization and not well-controlled (but stable) asthma See text for further information and safety advice
Additional controller options (e.g., add-on LAMA at Step 4, add-on LTRA) have less evidence for efficacy or for safety than Tracks 1 or 2 (see text). Maintenance OCS should only ever be used as last resort.

AIR: anti-inflammatory reliever; HDM: house dust mite; ICS: inhaled corticosteroid; Ig: immunoglobulin; IL: interleukin; LABA: long-acting beta$_2$-agonist; LAMA: long-acting muscarinic antagonist; LTRA: leukotriene receptor antagonist; MART: maintenance-and-reliever therapy with ICS-formoterol; OCS: oral corticosteroid; SABA: short-acting beta$_2$-agonist; SLIT: subcutaneous immunotherapy; TSLP: thymic stromal lymphopoietin

Allergy & Asthma NETWORK

(Example of action plan template for budesonide/formoterol. A similar action plan could be constructed for other ICS/formoterol formulations, eg, mometasone/formoterol)

My Asthma Action Plan

For Single Inhaler Maintenance and Reliever Therapy (SMART) with budesonide/formoterol

Name: _____ **Action plan provided by:** _____

Date: _____ **Doctor:** _____

Usual best PEF: _____ L/min *(if used)* **Doctor's phone:** _____

Normal mode

My SMART Asthma Treatment is:

☐ budesonide/formoterol 160/4.5 (12 years or older)

☐ budesonide/formoterol 80/4.5 (4-11 years)

My Regular Treatment Every Day:

(Write in or circle the number of doses prescribed for this patient)

Take [1, 2] inhalation(s) in the morning

and [0, 1, 2] inhalation(s) in the evening, every day

Reliever

Use 1 inhalation of budesonide/formoterol whenever needed for relief of my asthma symptoms

I should always carry my budesonide/formoterol inhaler

My asthma is stable if:

- I can take part in normal physical activity without asthma symptoms

AND

- I do not wake up at night or in the morning because of asthma

Other Instructions

_____

_____

Asthma Flare-up

If over a Period of 2-3 Days:

- My asthma symptoms are getting worse **OR NOT** improving

OR

- I am using more than 6 budesonide/formoterol reliever inhalations a day (if aged 12 years or older) or more than 4 inhalations a day (if aged 4-11 years)

I should:

☐ Continue to use my regular everyday treatment **PLUS** 1 inhalation budesonide/formoterol whenever needed to relieve symptoms

☐ Start a course of prednisolone

☐ Contact my doctor

Course of Prednisolone Tablets:

Take _____ mg prednisolone tablets per day for _____ days **OR**

_____

_____

If I need more than **12 budesonide/formoterol inhalations (total)** in any day (or more than 8 inhalations for children 4-11 years), I **MUST** see my doctor or go to the hospital the same day.

Asthma Emergency

Signs of an Asthma Emergency:

- Symptoms getting worse quickly
- Extreme difficulty breathing or speaking
- Little or no improvement from my budesonide/formoterol reliever inhalations

If I have any of the above danger signs, I should dial _____ for an ambulance and say I am having a severe asthma attack.

While I am waiting for the ambulance start my asthma first aid plan:

- Sit upright and stay calm.
- Take 1 inhalation of budesonide/formoterol. Wait 1-3 minutes. If there is no improvement, take another inhalation of budesonide/formoterol (up to a maximum of 6 inhalations on a single occasion).
- If only albuterol is available, take 4 puffs as often as needed until help arrives.
- Start a course of prednisolone tablets (as directed) while waiting for the ambulance.
- Even if my symptoms appear to settle quickly, I should see my doctor immediately after a serious attack.

Modified from Australian action plan with permission from National Asthma Council Australia and AstraZeneca Australia

Action plan recommendations for adults and adolescents vary depending on the reliever

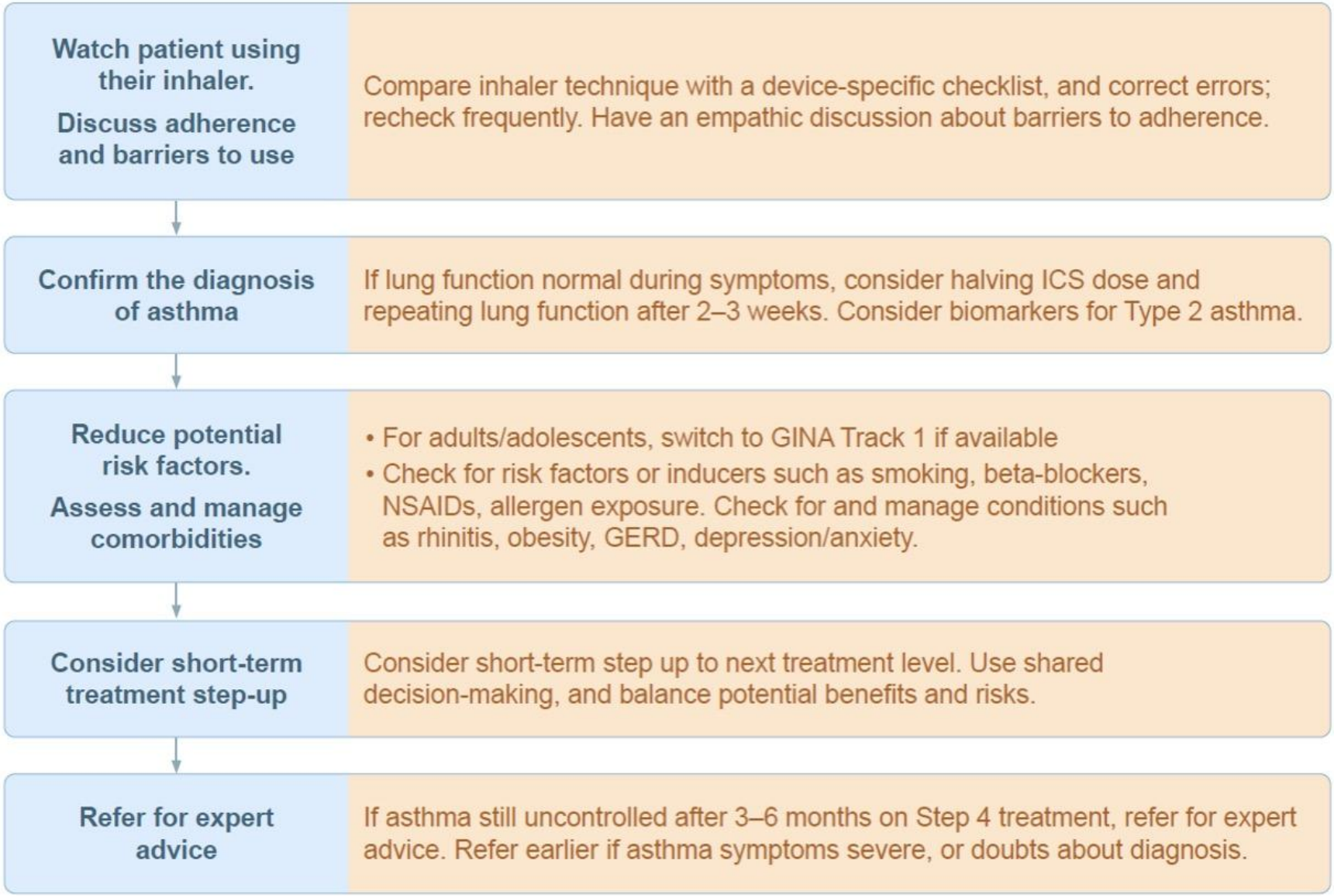
- Increase reliever as needed (within maximum recommended doses)
  - With ICS-formoterol or ICS-SABA reliever, the patient immediately receives additional ICS as well as symptom relief
- Continue maintenance ICS-containing treatment
  - If the reliever is ICS-formoterol or ICS-SABA, **continue** the patient's usual maintenance dose of ICS or ICS-LABA
  - If the reliever is SABA, **increase** maintenance ICS-containing dose for at least 1–2 weeks
- Use an action plan template that is customized to the patient's treatment

Track & step	Usual asthma treatment	Short-term action plan change (1–4 weeks) for worsening asthma	Evidence level
GINA Track 1 with ICS-formoterol reliever*			
Steps 1–2	As-needed-only ICS-formoterol (AIR-only)	For symptom relief, use 1 inhalation of ICS-formoterol (e.g., budesonide-formoterol 160/4.5 mcg or BDP-formoterol 100/6 mcg) whenever needed. Maximum 12 inhalations in any 24-hour period.	A
Steps 3–5	Maintenance and reliever therapy (MART) with ICS-formoterol	Continue usual maintenance dose of ICS-formoterol. For symptom relief, use 1 inhalation of ICS-formoterol whenever needed. Maximum total 12 inhalations in any 24-hour period (as-needed + maintenance doses).	A
GINA Track 2 with combination ICS-SABA reliever#			
Step 1	As-needed-only combination ICS-SABA	For symptom relief, take 2 inhalations of ICS-SABA as needed. Do not take more than 6 doses (12 inhalations) in any 24-hour period.	B
Step 2	Maintenance ICS	Continue usual maintenance ICS dose. For symptom relief, take 2 inhalations of ICS-SABA as needed. Do not take more than 6 doses (12 inhalations) of ICS-SABA in any 24-hour period.	A
Steps 3–4	Maintenance ICS-LABA	Continue usual maintenance ICS-LABA dose. For symptom relief, take 2 inhalations of ICS-SABA as needed. Do not take more than 6 doses (12 inhalations) of ICS-SABA in any 24-hour period.	B
GINA Track 2 with SABA reliever			
Step 1	As-needed SABA plus ICS (separate inhalers)	For symptom relief, use SABA as below, and take ICS whenever SABA is taken (e.g., 1 inhalation of beclometasone 40 mcg per inhalation of SABA).	B
Step 2	Maintenance ICS	Consider quadrupling maintenance dose of ICS for 1–2 weeks. For symptom relief with SABA, see below.	B
Steps 3–4	Maintenance ICS-formoterol	Consider quadrupling maintenance dose of ICS-formoterol for 1–2 weeks. For symptom relief with SABA, see below.	B
	Maintenance ICS-LABA (non-formoterol)	Consider stepping up to higher dose formulation of ICS-LABA, if available. In adults, consider adding a separate ICS inhaler to quadruple ICS dose. For symptom relief with SABA, see below.	D
Reliever	As-needed SABA	For symptom relief, take 2 inhalations of SABA every 4–6 hours if needed. More frequent use or more inhalations of SABA is not recommended.	-

AIR: anti-inflammatory reliever; BDP: beclometasone dipropionate; ICS: inhaled corticosteroid; LABA: long-acting beta$_2$-agonist; MART: maintenance-and-reliever therapy with ICS-formoterol; SABA: short-acting beta$_2$-agonist

Conclusion

Investigating uncontrolled asthma in primary care



GERD: gastro-esophageal reflux disease; ICS: inhaled corticosteroid; NSAID: non-steroidal anti-inflammatory drug; SABA: short-acting beta$_2$-agonist

Conclusion

- 천식 악화는 **호흡기 증상의 지속적인 악화와 함께 폐기능이 저하되는 상태**를 말하며,이러한 악화가 반복될수록 폐기능 저하와 삶의 질 악화를 초래한다.
- 천식 악화를 예방하기 위해서는 **조절 가능한 위험인자를 정확히 파악**하고,악화 및 천식 관련 사망 위험을 높이는 요인들에 대한 **체계적인 예방 전략**이 중요하다.
- 치료의 목표는 **신속히 기류 폐쇄 및 저산소혈증을 개선시키고, 염증성 병태생리의 조절, 재발을 예방**하는 것으로 초기치료로는 **흡입속효성베타작용제의 반복 흡입, 전신 스테로이드의 조기 투여, 산소 공급이** 권장된다.
- 급성 악화 치료 이후에는 ICS 포함한 유지요법인 MART을 권장하고, **문서화된 천식행동계획**대한 교육을 시행해야한다.

감사합니다.