Bronchial asthma

Teaching form: Lecture

Auditorium: General medicine students ELP

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Clinic of Pneumology and Phthisiology

Updated: Nov 7th 2025

- Asthma is a heterogenous disease, usually characterized by chronic airways inflammation.
- It is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that vary over time and in intensity, together with variable expiratory airflow limitation.

GINA 2022-24

Patient’s point of view...

History

Asthma - Greek word for shortness of breath.

Mid 19th century - variable airflow obstruction.

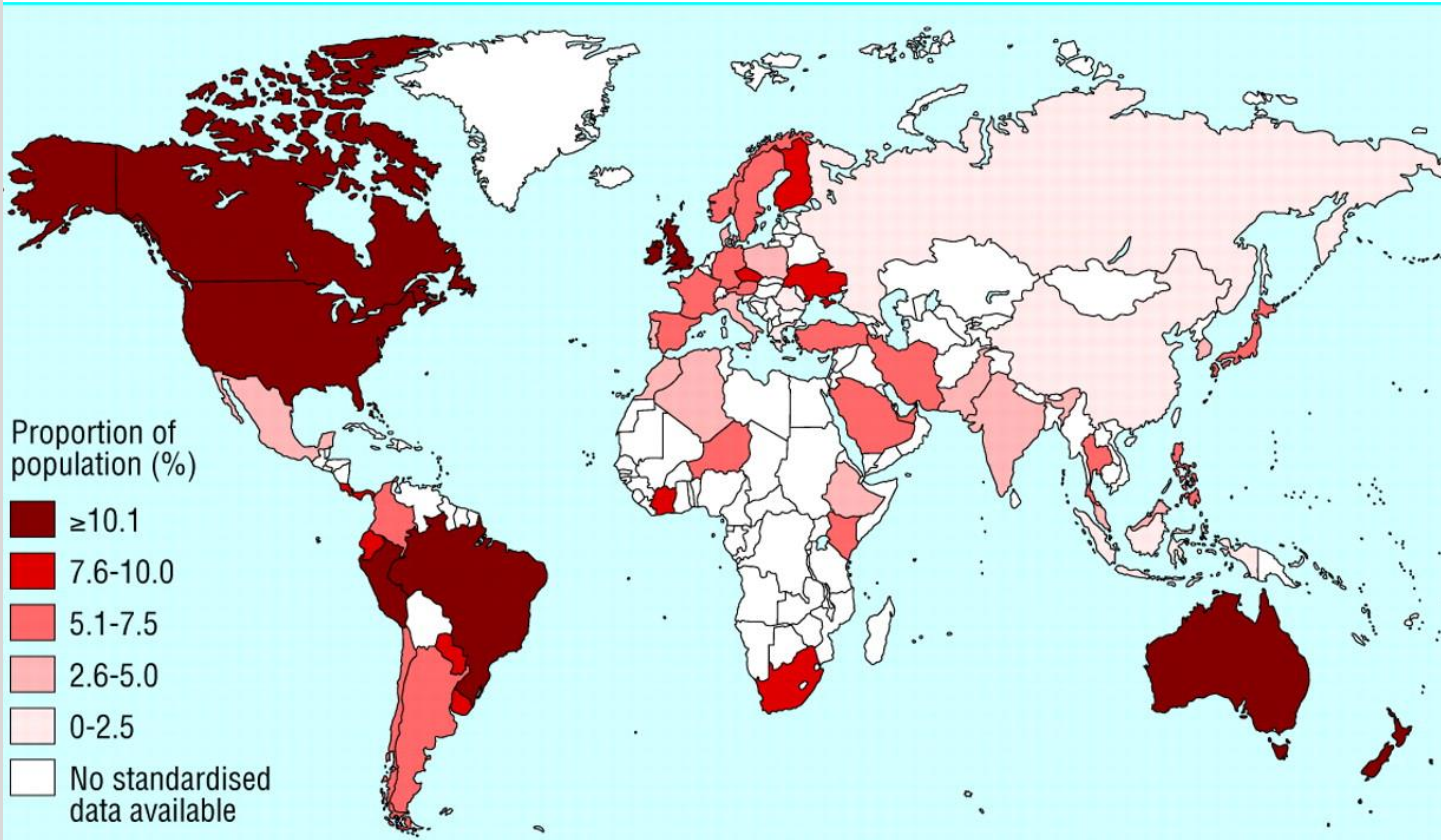
Dr. Henry Hyde Salter *On Asthma and Its Treatment 1860*:

- "Paroxysmal dyspnoea of a peculiar character with intervals of healthy respiration between attacks."
- Cause: contraction of smooth muscle that differentiated it from "bronchial catarrh, recent bronchitis and old bronchitis".
- Unusual cells in asthmatic sputum.

Asthma global data

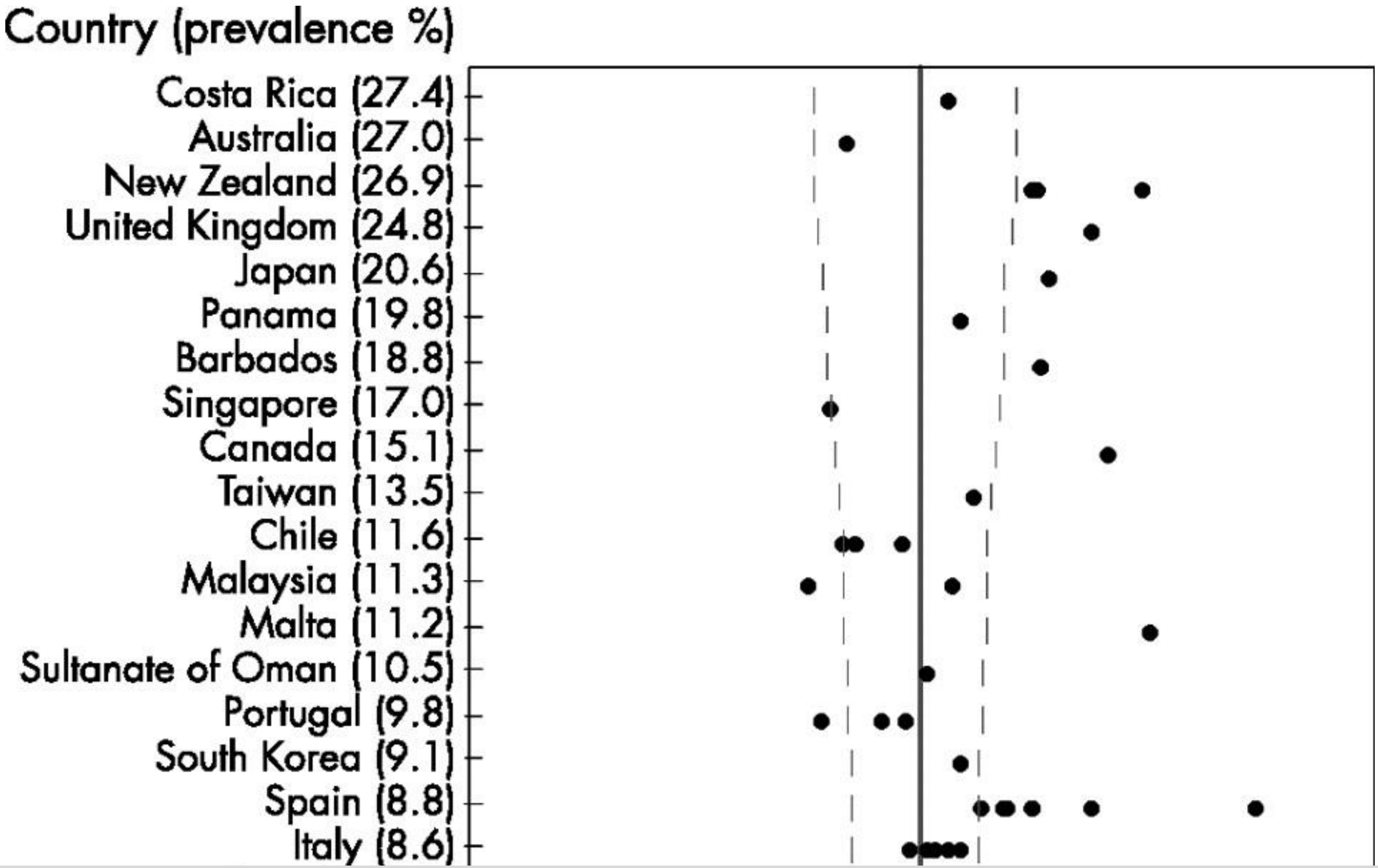
- 300 million people affected
- 15 million DALYs lost annually
- 250,000 deaths annually
- $20.7 billion expenditures for health and lost productivity annually

Asthma prevalence worldwide

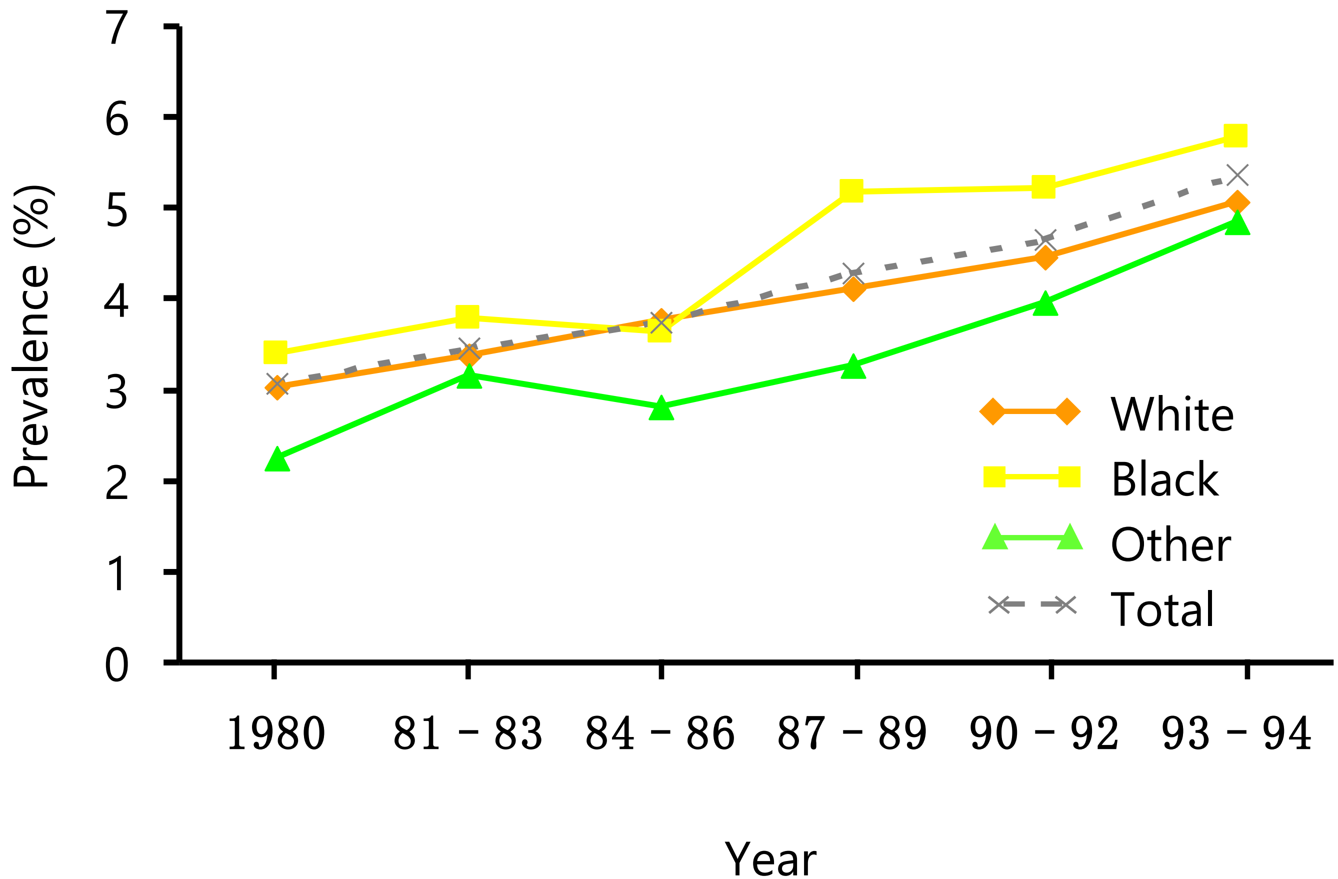


Definition Epidemiology Pathogenesis Diagnosis Differential diagnosis Treatment

Asthma prevalence increase

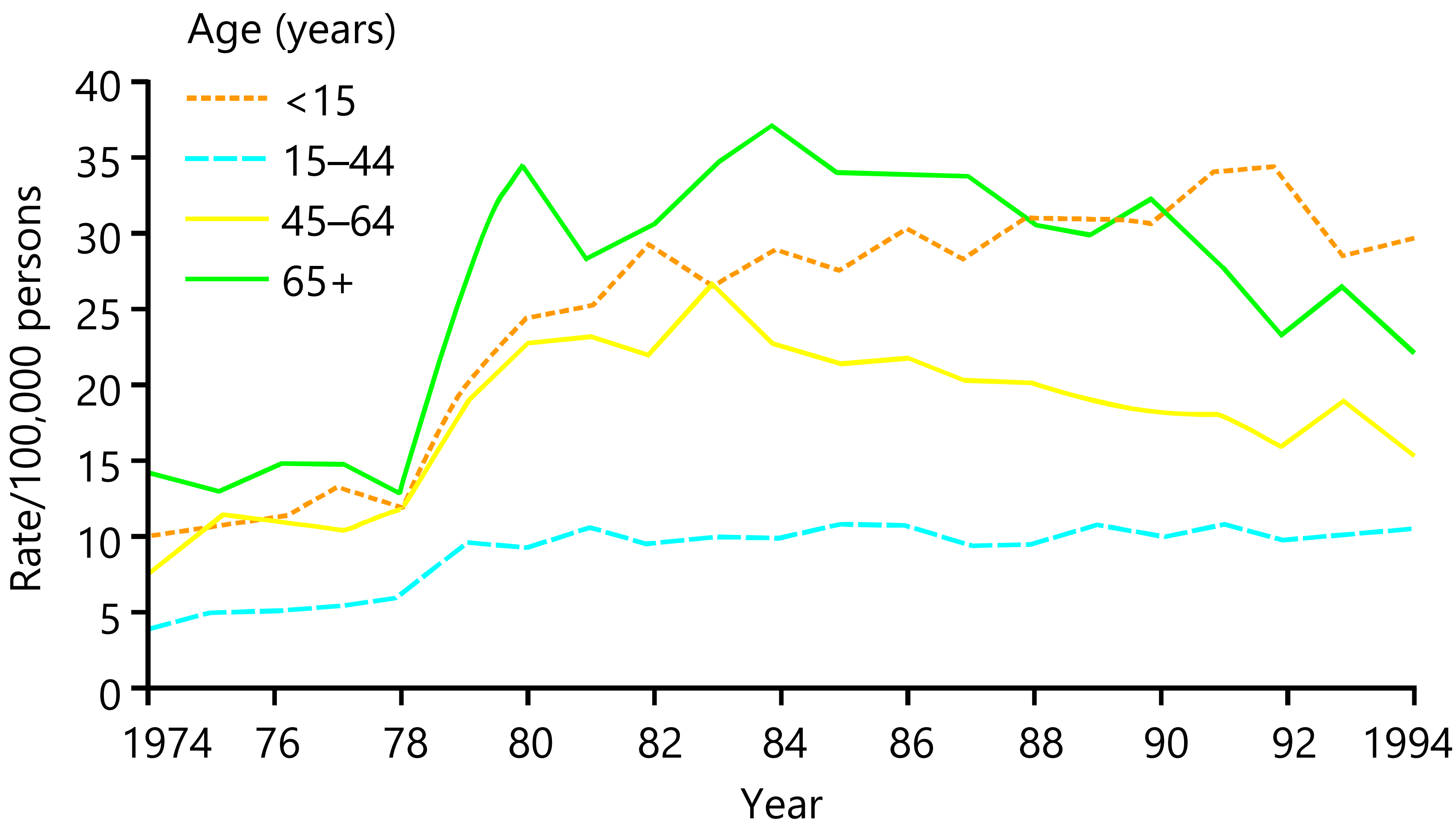


Asthma prevalence in USA by race, 1980–1994



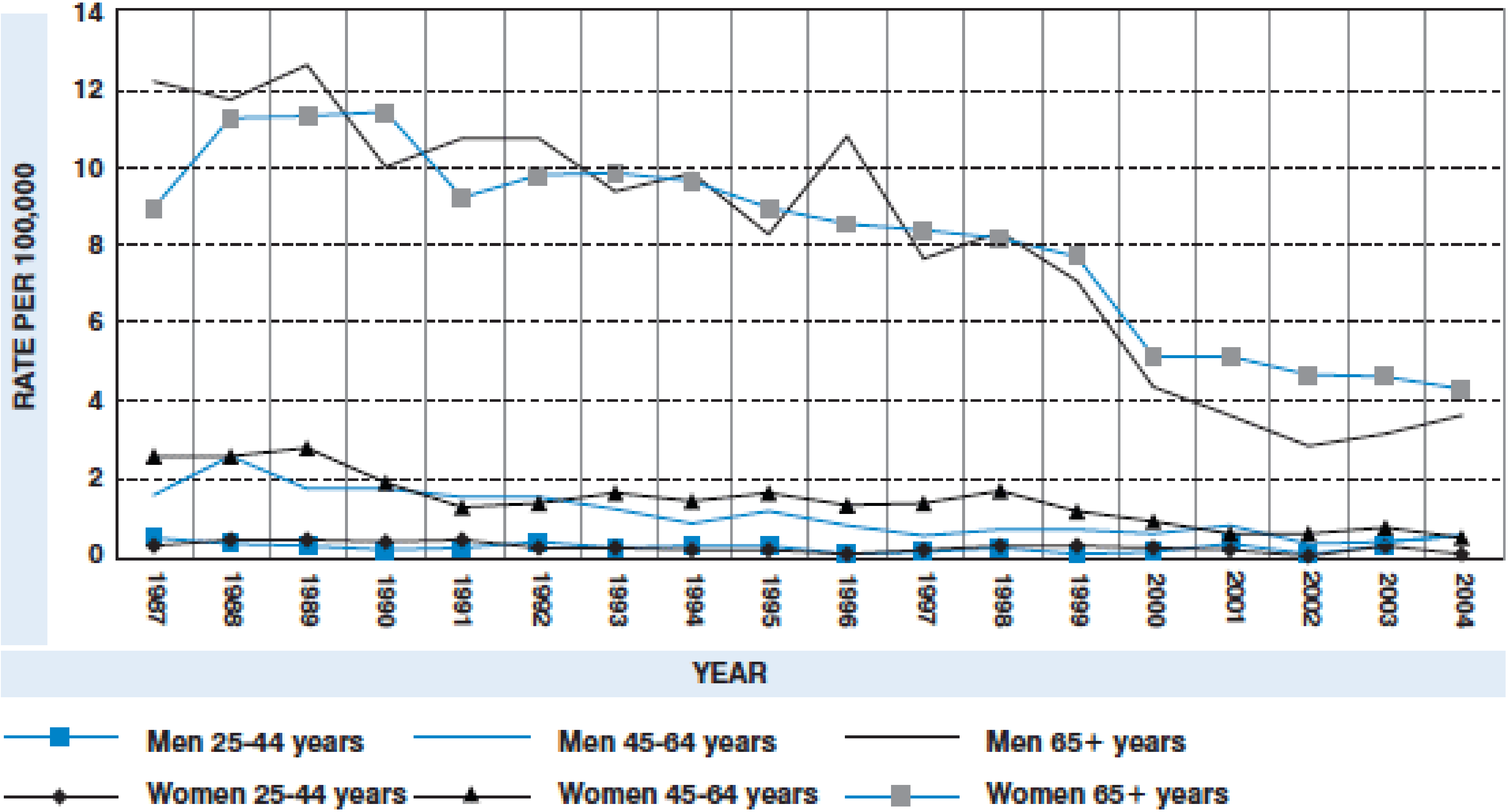
Mannino DM et al. National Health Interview Survey.
Mortal Wkly Rep CDC Surveill Summ 1998

Hospitalization rates for asthma in USA



Global Initiative for Asthma (GINA). WHO/NHLBI, 1995

Asthma mortality in Canada, 1987–2004



Source: Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, using Statistics Canada annual mortality data.

- exaggerated responsiveness of the airways to various stimuli,
- rather specific inflammation of the airways (CD4+ T-cells, eosinophils and metachromatic cells in the mucosa, increased thickness of the reticular layer of the epithelial basement membrane,
- not a single disease – more likely a syndrome!

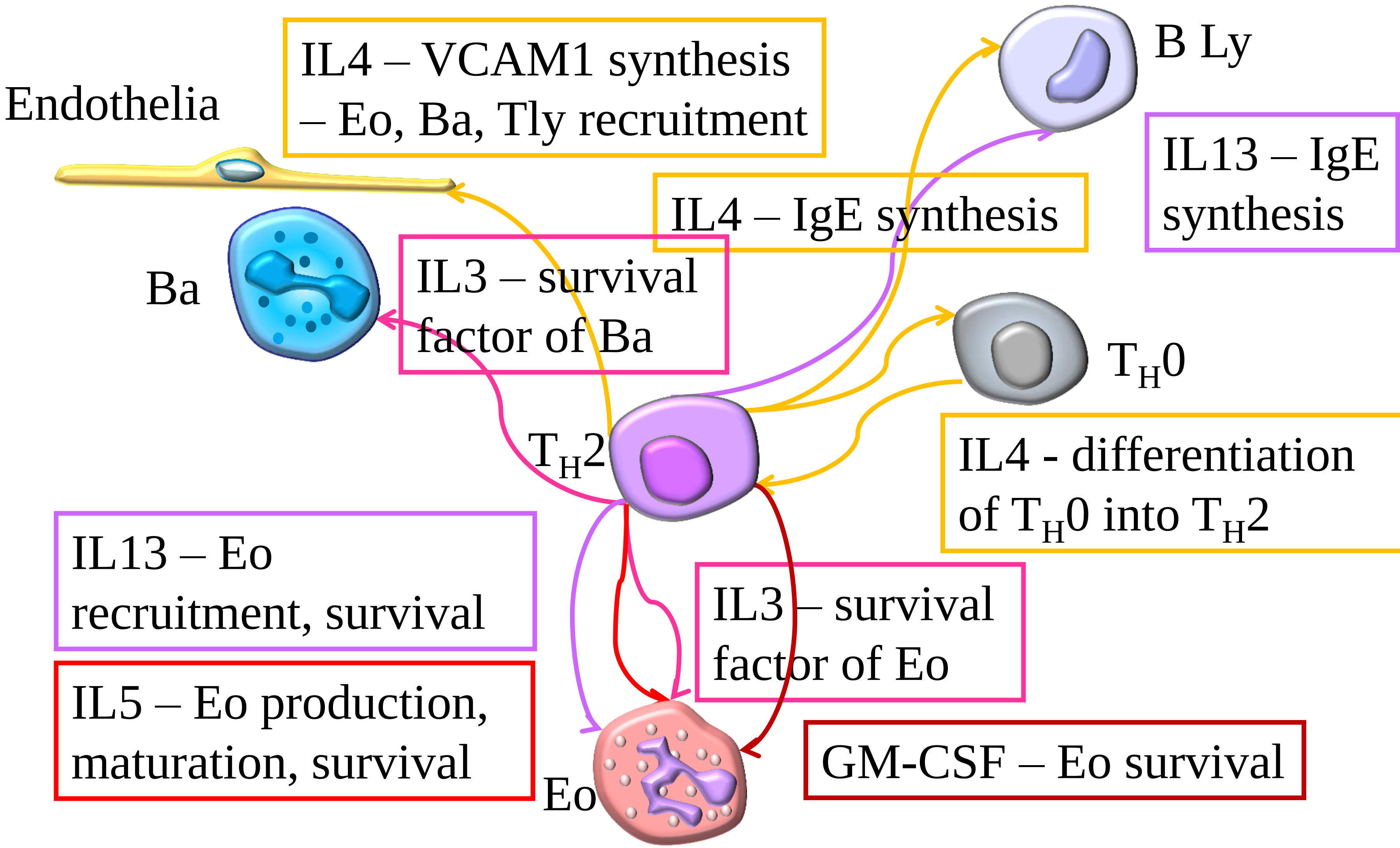
Asthma endotyping based on inflammatory granulocytic involvement

Sputum cells		Neutrophils	
	Cell counts	**Elevated**	**Not elevated**
Eosinophils	**Elevated**	mixed-granulocytic asthma~3% of asthmatics	eosinophilic asthma~42% of asthmatics
	Not elevated	neutrophilic asthma~16% of asthmatics	paucigranulocytic asthma~40% of asthmatics

Asthma endotyping based on T_H2 inflammation

- **Type 2-high asthma** (allergen-driven, Eo ≥ 150/ul, or FENO ≥ 20 ppb, or sputum Eo ≥ 2%)
  - **Early-onset atopic asthma** (most common in childhood)
  - **Late-onset eosinophilic asthma** (adults with no diagnosed atopy, may frequently be allergic).
  - **Aspirin-exacerbated respiratory disease** (late onset, severe, chronic rhinosinusitis with nasal polyps, sub-phenotype of late-onset eosinophilic asthma)
  - **Allergic bronchopulmonary aspergillosis**
  - **Cough variant asthma**
- **Type 2-low asthma** (rare, often severe, refractory to ICS)
  - **Asthma with obesity**

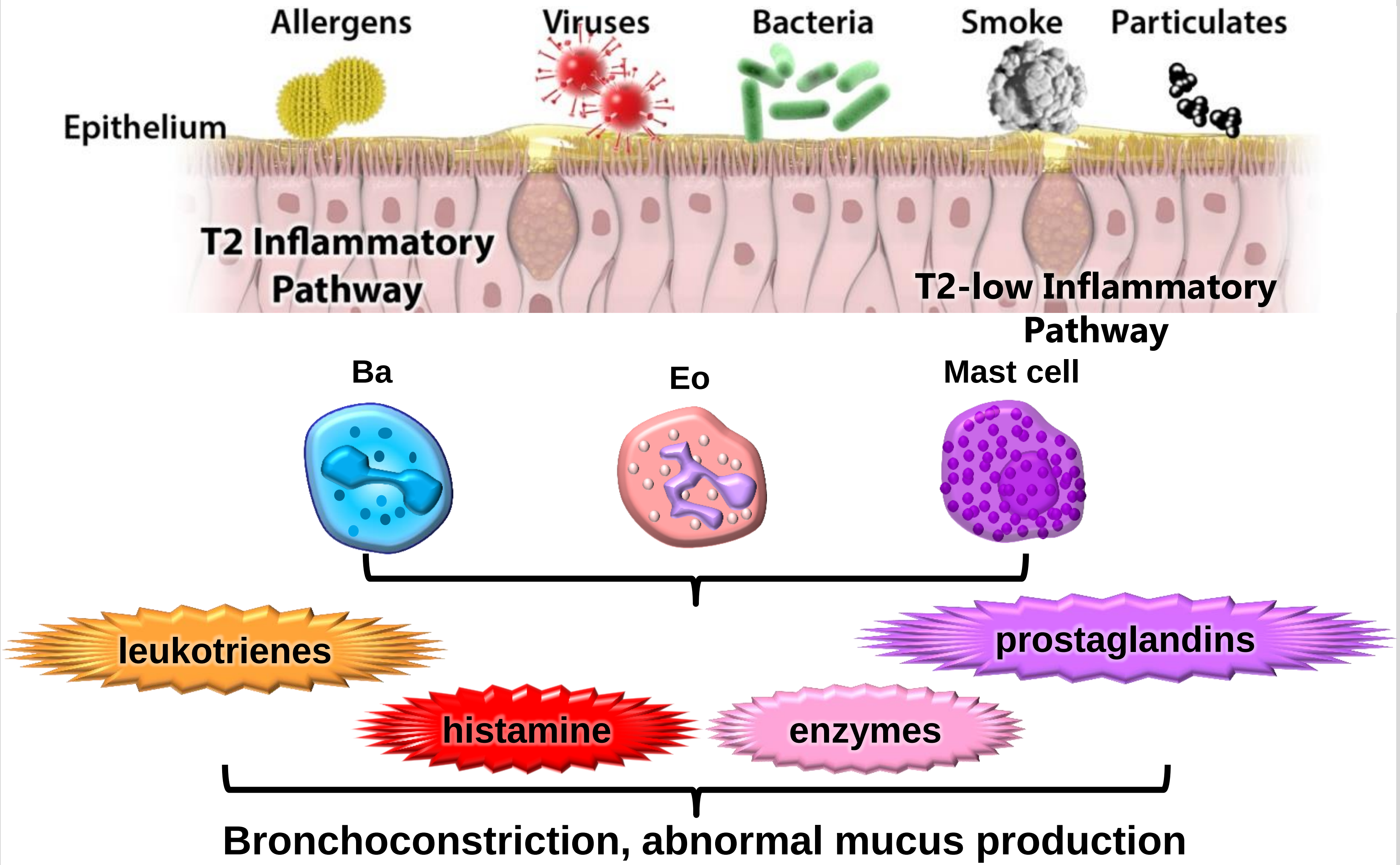
T_H2 inflammation



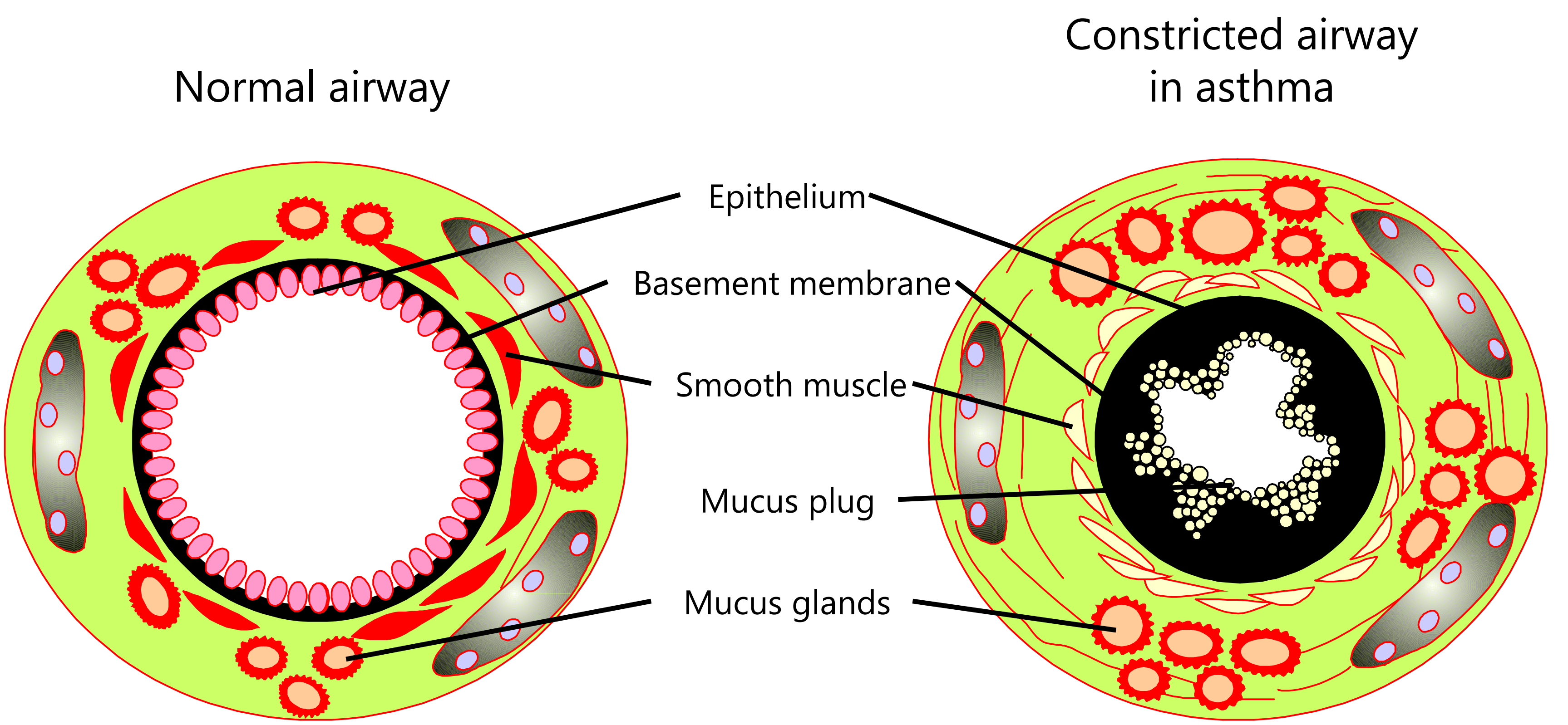
Non-T_H2 inflammation

- Obesity:
  - mechanical impairment of the lung function,
  - GER,
  - pro-inflammatory mediators from the adipose tissue (CRP, TNFα, TGFβ, IL6)
- Late onset (>40).
- Smoking.
- Occupational exposures.

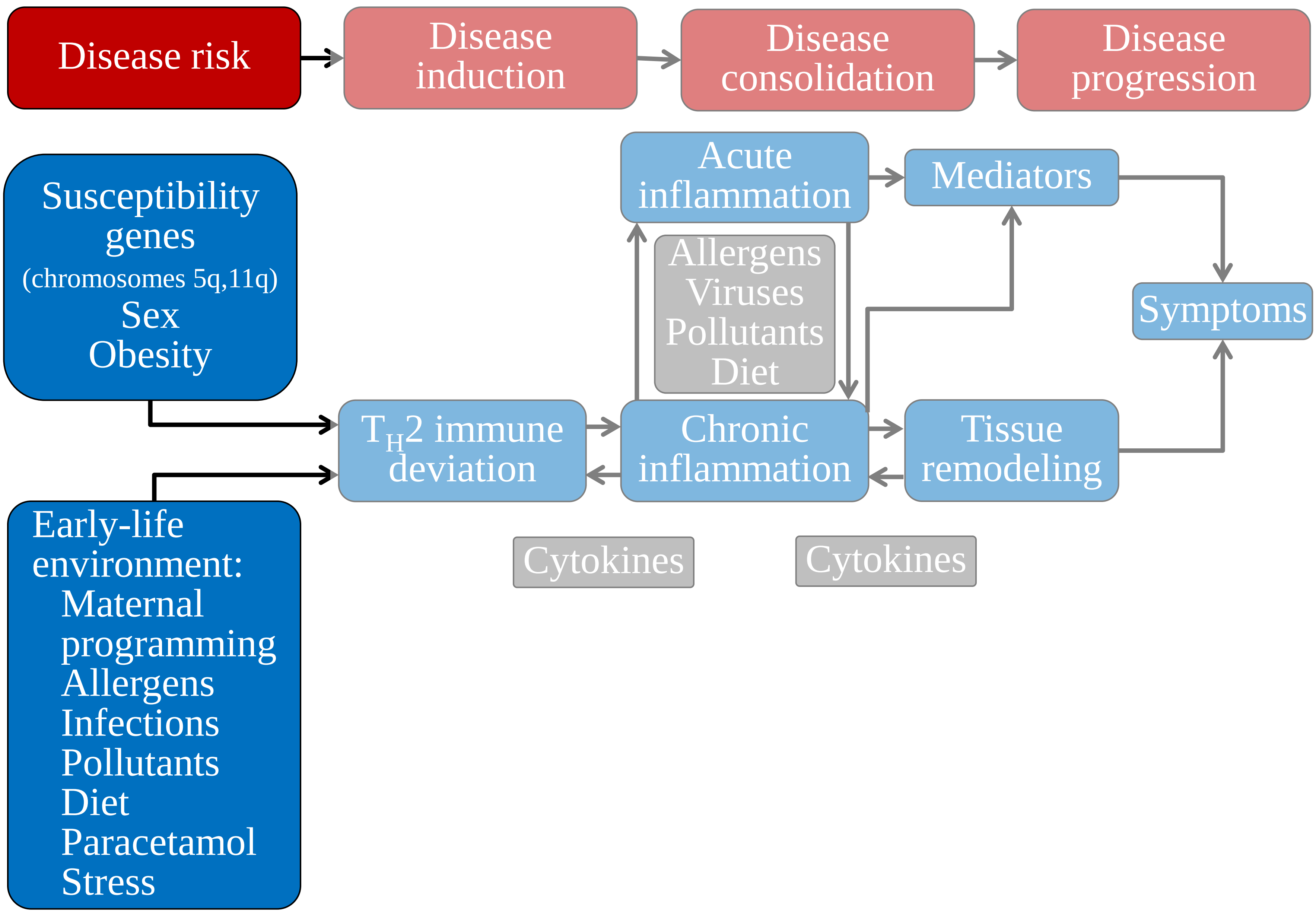
Common inflammatory pathway in asthma



Pathological changes in asthma



Robbins Pathologic Basis of Disease. 6th ed. WB Saunders, 1999


Disease risk
Disease induction
Disease consolidation
Disease progression
Susceptibility genes
(chromosomes 5q,11q)
Sex
Obesity
Early-life environment:
Maternal programming
Allergens
Infections
Pollutants
Diet
Paracetamol
Stress
Acute inflammation
Mediators
Allergens
Viruses
Pollutants
Diet
Symptoms
T_H2 immune deviation
Chronic inflammation
Tissue remodeling
Cytokines
Cytokines

Disease risk

Susceptibility genes (chromosomes 5q,11q)
Sex
Obesity

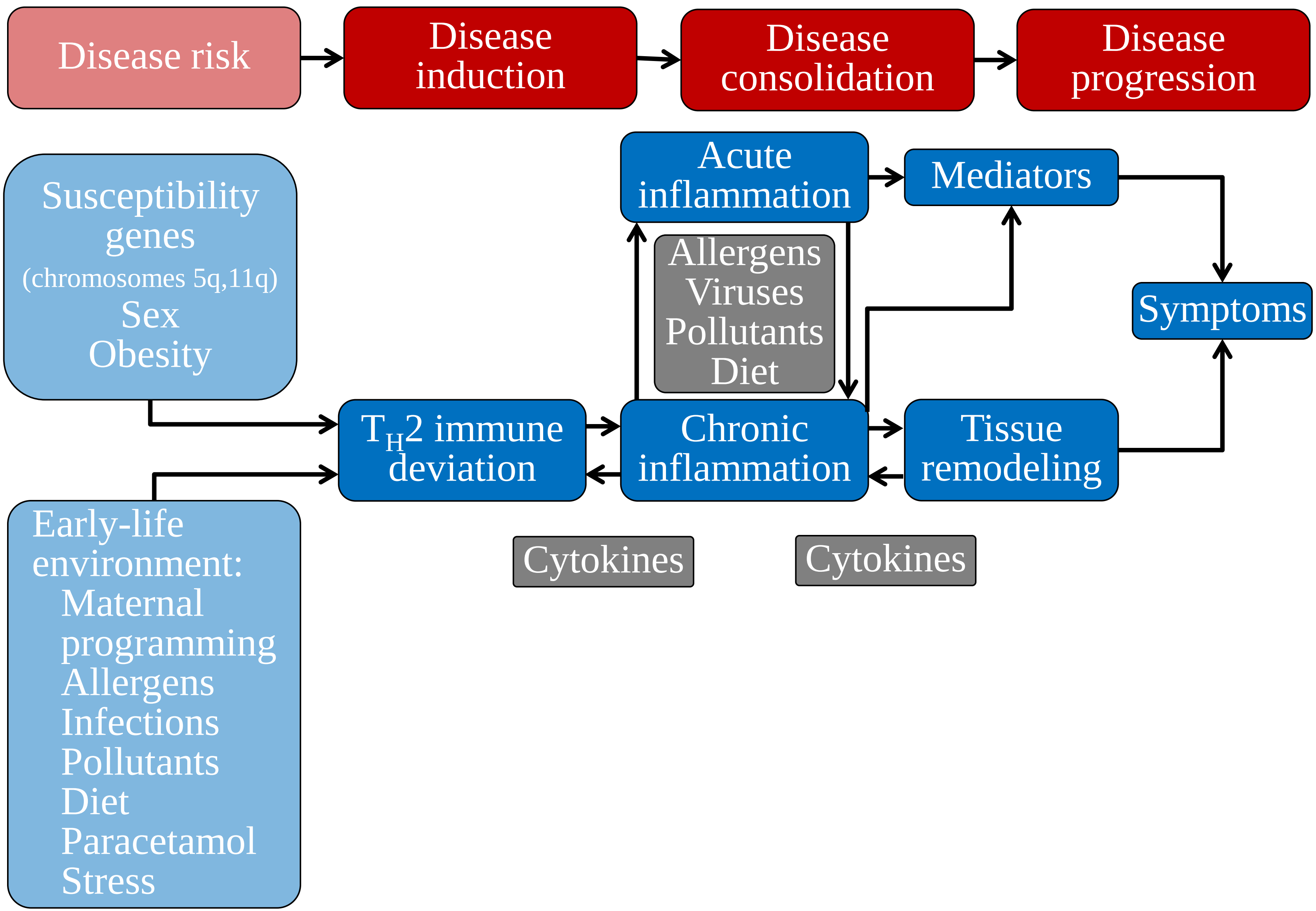
- 5q – IgE + airways hyperresponsiveness
- Prior to 14 M:F=2:1
  Adults M<F (lung and aw development)
- BMI>30 [kg/m^2]
  females with abdominal obesity
  airways geometry?
  pro-inflammatory state

Early-life environment:
- Maternal programming
- Allergens
- Infections
- Pollutants
- Diet
- Paracetamol?
- Stress

Infants of smoking mothers 4 times more likely to develope wheezing
Maternal obesity increases the odd by 2-3% per each kg/m^2

cow milk, soy, lack of fruits and vegetables,
increased omega-6 polyunsaturated fatty acids
decreased omega-3 polyunsaturated fatty acids

Low cortisol levels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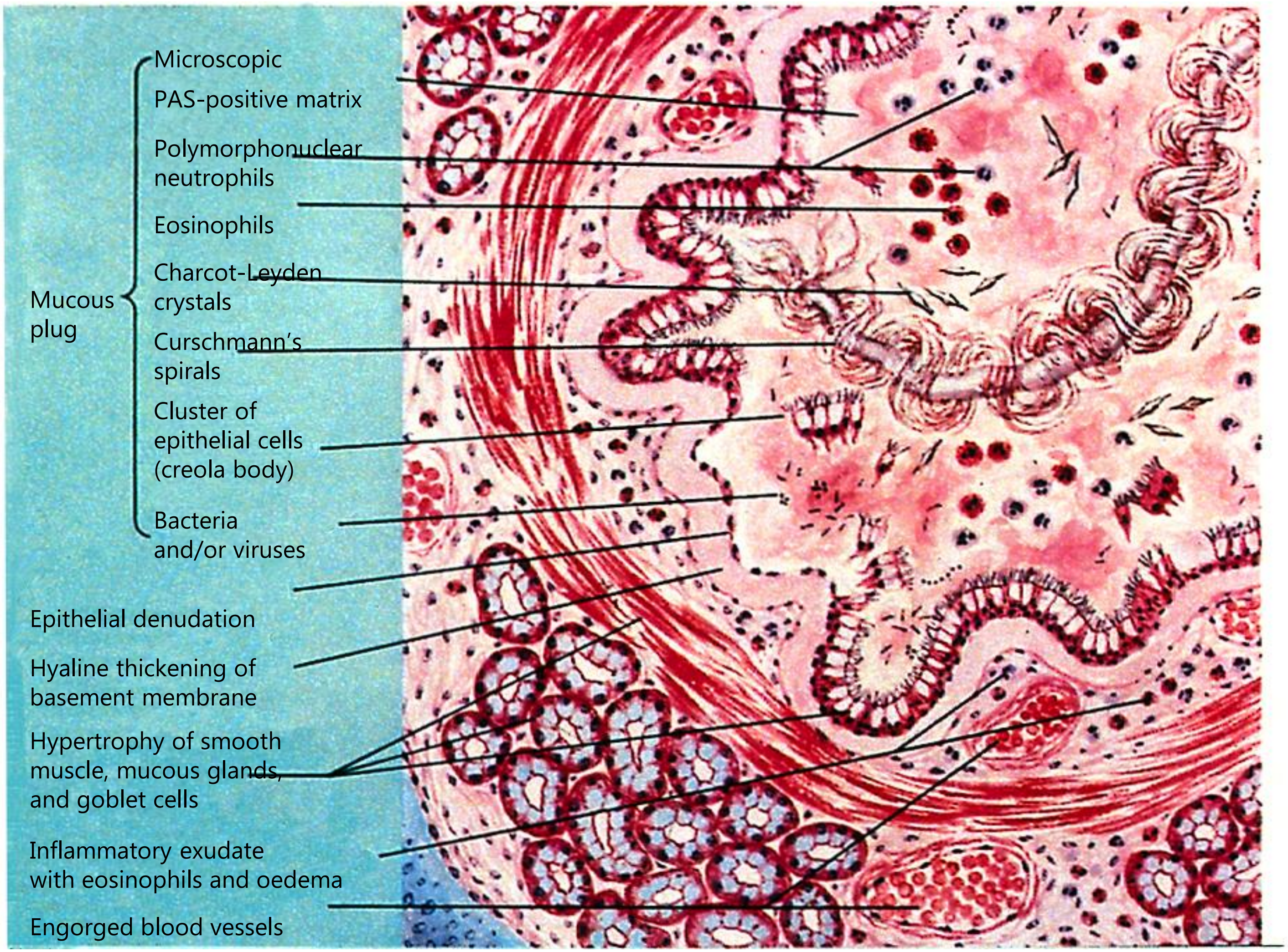
Pathological changes in asthma



Triggers

Inducers
allergens
viral infections
occupational

Enhance inflammatory response

Provokers
exercise
irritants
emotions
aspirin

Activate bronchospasm

Adapted from Busse WW. J Allergy Clin Immunol 1998

Minimum requirements for the diagnosis

- clinical history + lung function test

Symptoms

- wheezing
- chest tightness
- episodic shortness of breath

90% of patients

- chronic cough

all symptoms are non-specific!

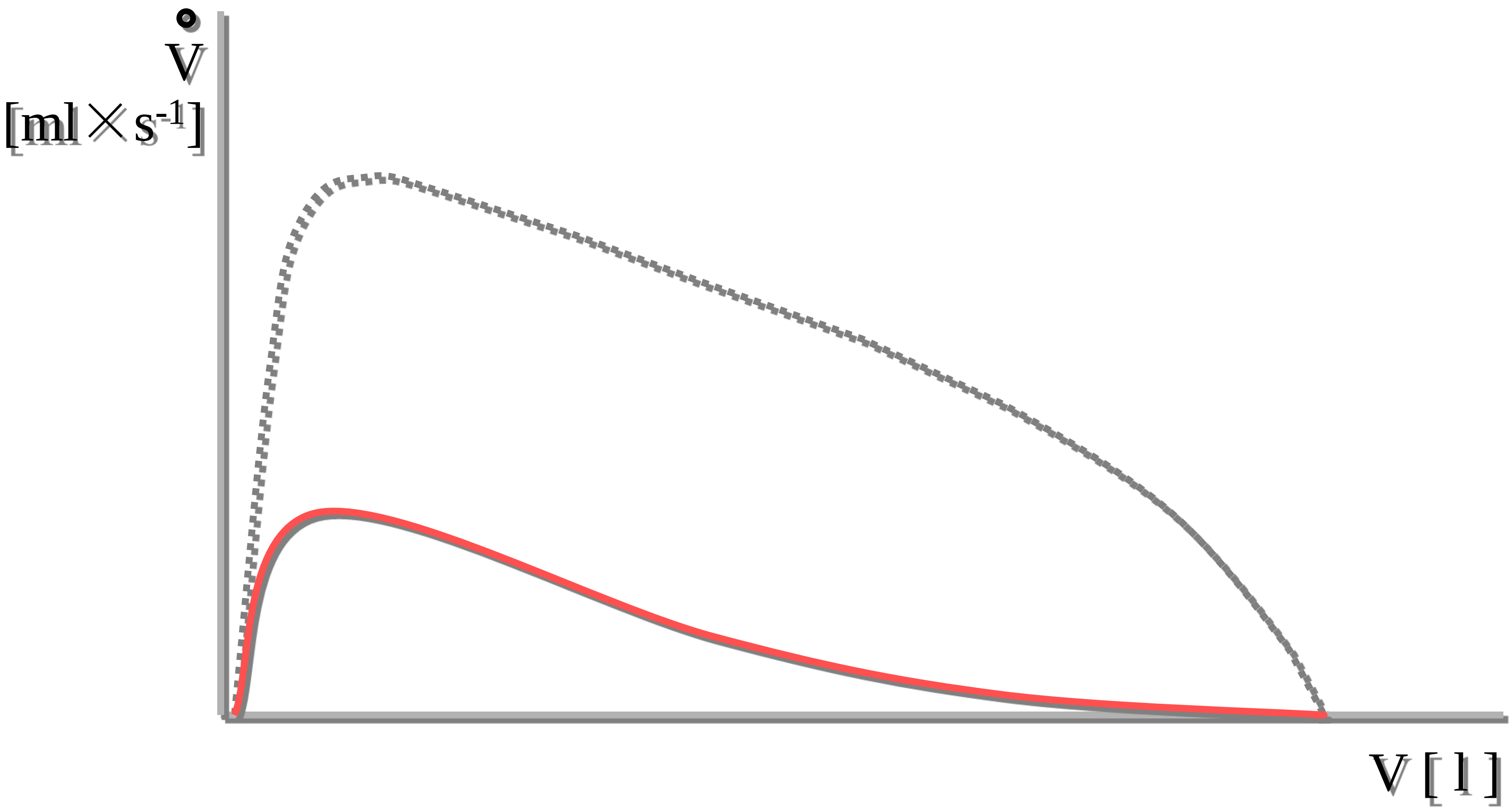
Physical examination

- normal in stable condition
- during attacs:
  - general signs:
    - use of accessory muscles
    - intercostal recession
    - anxiety
    - cyanosis
    - drowsiness, confusion
    - tachycardia
  - on chest:
    - signs of acute hyperinflation:
      - barrel-chest, hypersonorous percutoric sound, low diaphragmatic position, poor diaphragmatic excursion
    - signs of airway obstruction
      - vesicular breathing, prolonged expiration, expiratory wheezing, rhonchi

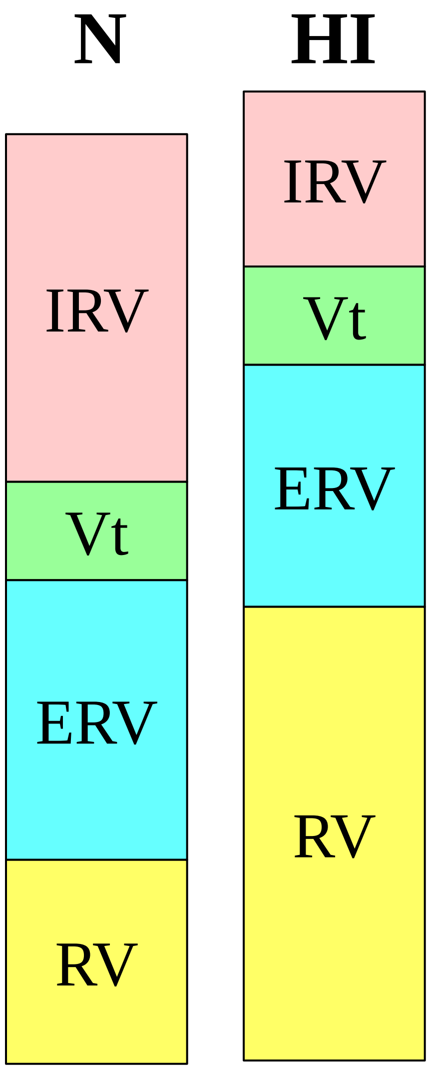
Lung function test

- obstructive ventilatory disorder
- hyperinflation of the lung
- reversibility of the obstruction
- diurnal variability of the obstruction
- airway hyperresponsiveness
- increased lung diffusion capacity
- increased FENO

Obstructive ventilatory disorder

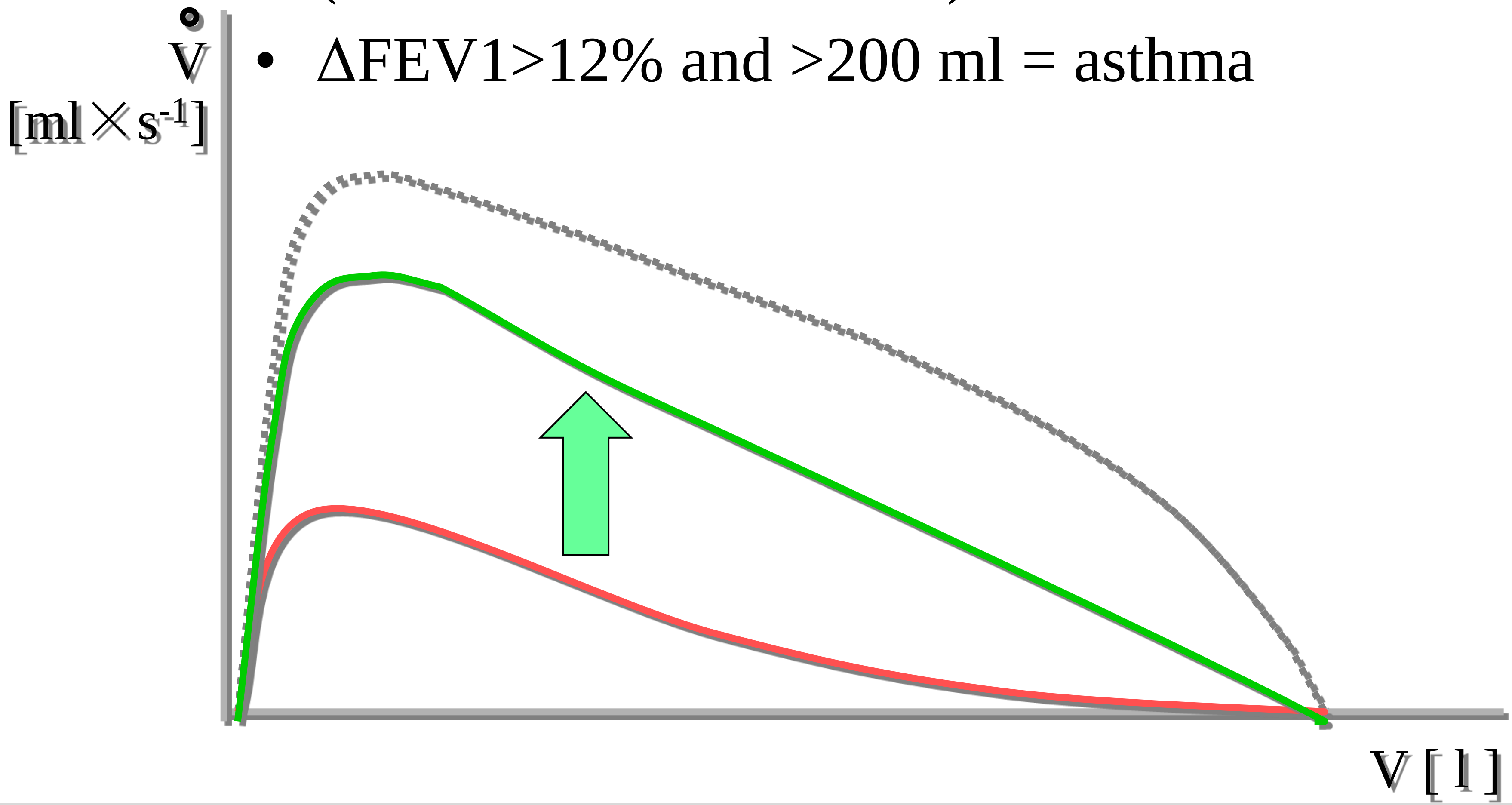


Hyperinflation of the lung



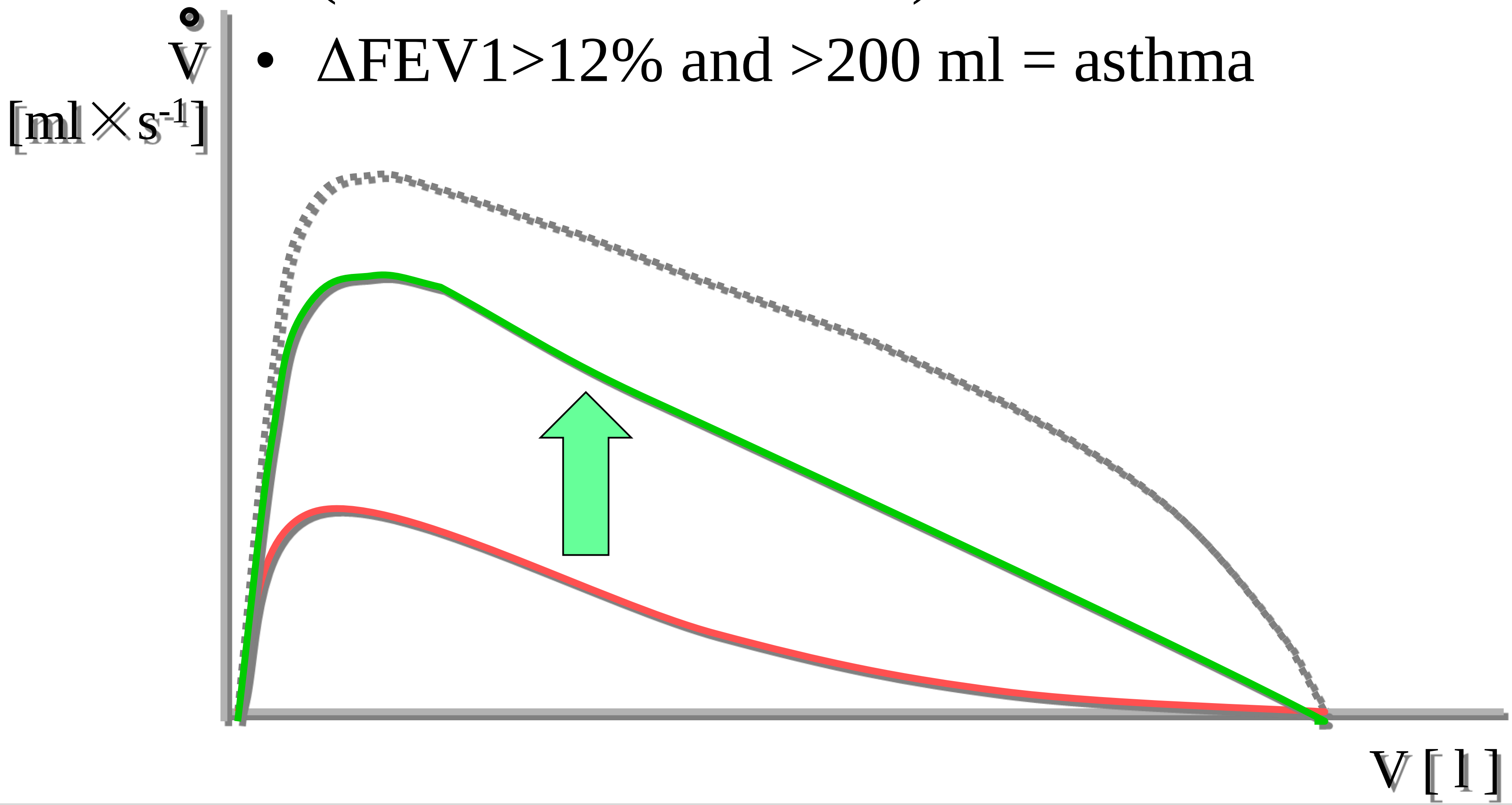
Reversibility of the obstruction to bronchodilators

- (FEV1after-FEV1before)/FEV1before × 100
- ΔFEV1>12% and >200 ml = asthma



Variability of the obstruction between the visits

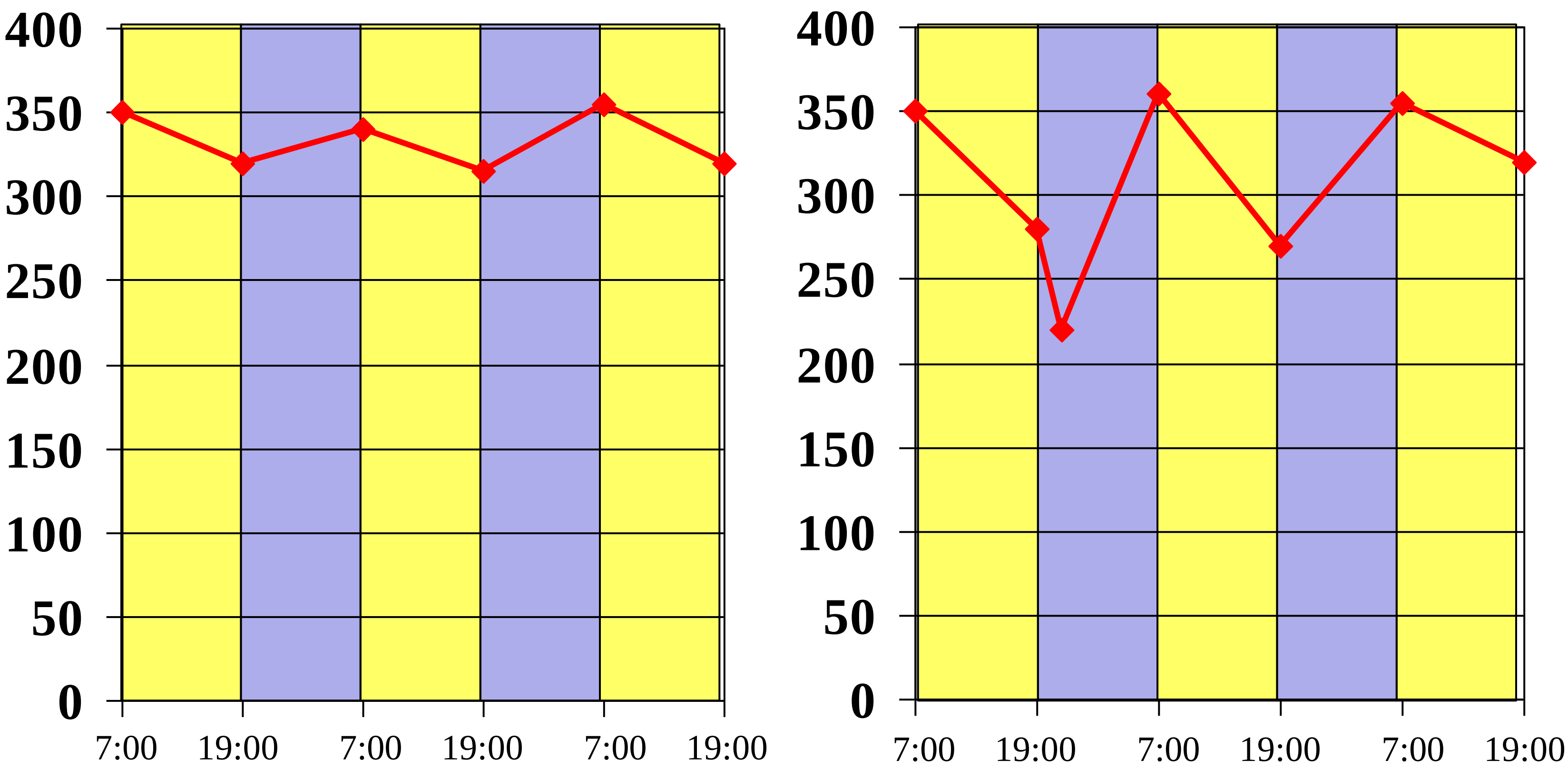
- (FEV1best-FEV1worst)/FEV1best × 100
- ΔFEV1>12% and >200 ml = asthma



Diurnal variability of the obstruction

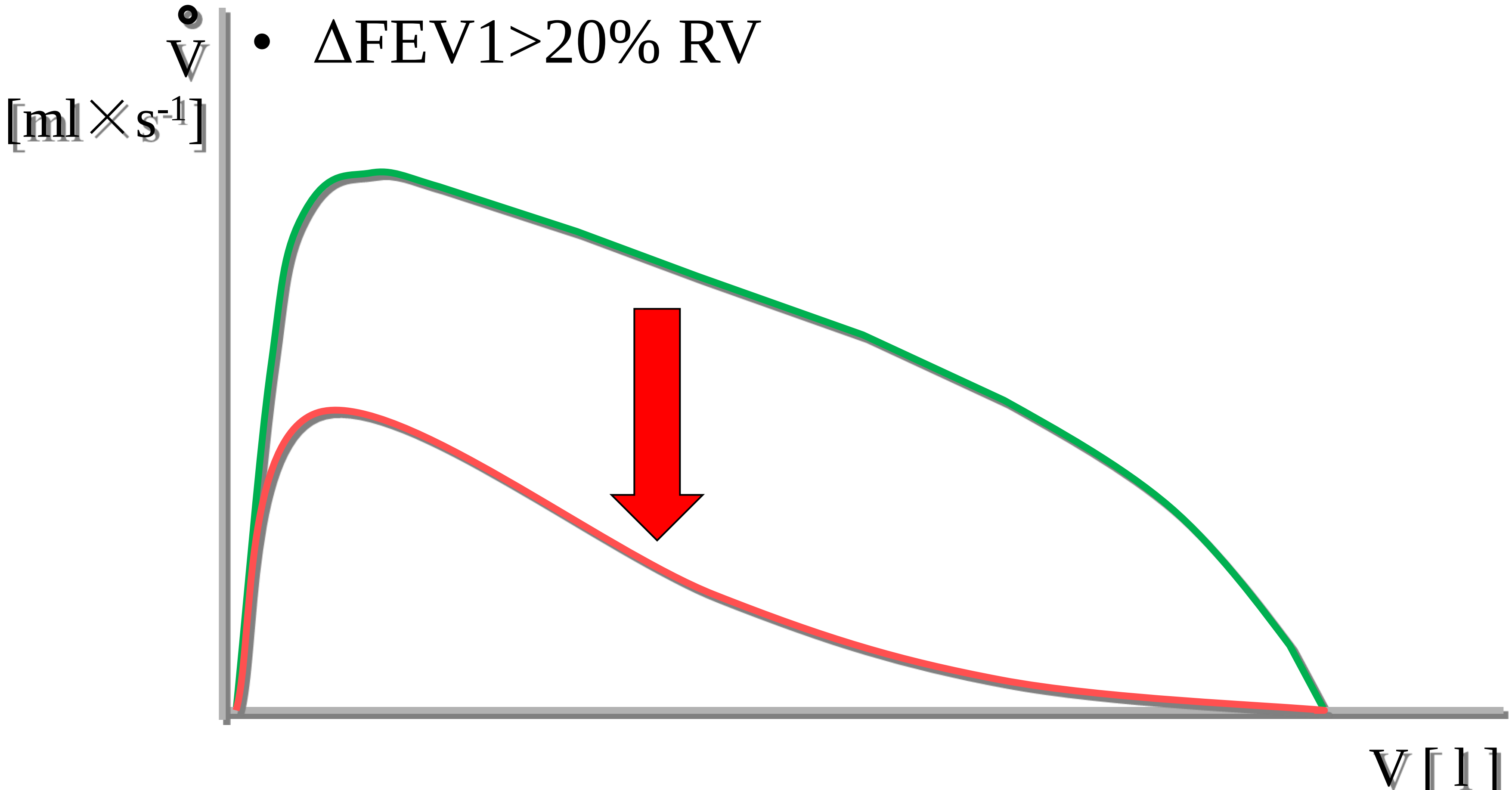
Diurnal variability of the obstruction

- (PEFmax-PEFmin)/[(PEFmax+PEFmin)/2]×100
- variability >10% = asthma



Airway hyperresponsiveness

- ΔFEV1>20% RV



Lung function test

- obstructive ventilatory disorder
- hyperinflation of the lung
- reversibility of the obstruction
- diurnal variability of the obstruction
- airway hyperresponsiveness
- increased lung diffusion capacity
- increased FENO

Allergy tests

- Skin tests
- Specific IgE
- Total IgE level – no diagnostic value

Asthma severity (before treatment)

	Intermitent	**Mild persistent**	**Moderate persistent**	**Severe persistent**
Symptoms	< once a week	> once a week < once a day	Daily	Daily
Exacerbations	Brief	May affect activity and sleep	May affect activity and sleep	Frequent
Nocturnal symptoms	< once a month	> once a month < once a week	> once a week	Frequent
FEV1 or PEF	≥80% predicted	≥80% predicted	60-80% predicted	<60% predicted
PEF or FEV1 variability	<20%	20-30%	>30%	>30%
			Daily use of SABA	Limitation of physical activities

Differential diagnosis

- Foreign body
- Endobronchial tumor
- Laryngeal dysfunction
- COPD
- Eosinophilic bronchitis
- Postinfectious airways hyperresponsiveness
- EGPA
- Left ventricular failure
- Carcinoid
- ABPA
- GERD
- Drugs (IACE, beta-blockers)

Asthma or COPD?

	Asthma	COPD
Onset	earlier	later
Smoking	?	+++
Attacs	+++	+
Nocturnal attacs	+++	+
History of allergy	+++	-
Family history	+++	?
PEF variablility	+++	+
Airway hyperresponsiveness	+++	+
Response to bronchodilators	+++	+
Effect of corticosteroids	+++	+
DLCO	normal or ↑	↓
FENO	↑	↓
Sputum	Eosinophilia	Neutrophilia
Allergy tests	+++	-

Drugs in asthma treatment

relievers:

SABA (salbutamol, fenoterol...)

anticholinergic agents (ipratropium)

controllers:

ICS (beclomethasone, budesonide, fluticasone, flunisolide, ciclesonide...)

LABA, ULABA (salmeterol, formoterol, indacaterol, vilanterol)

LAMA (thiotropium)

cromoglycate (nedocromil)

leukotriene modifying agents (zafirlucast, montelucast)

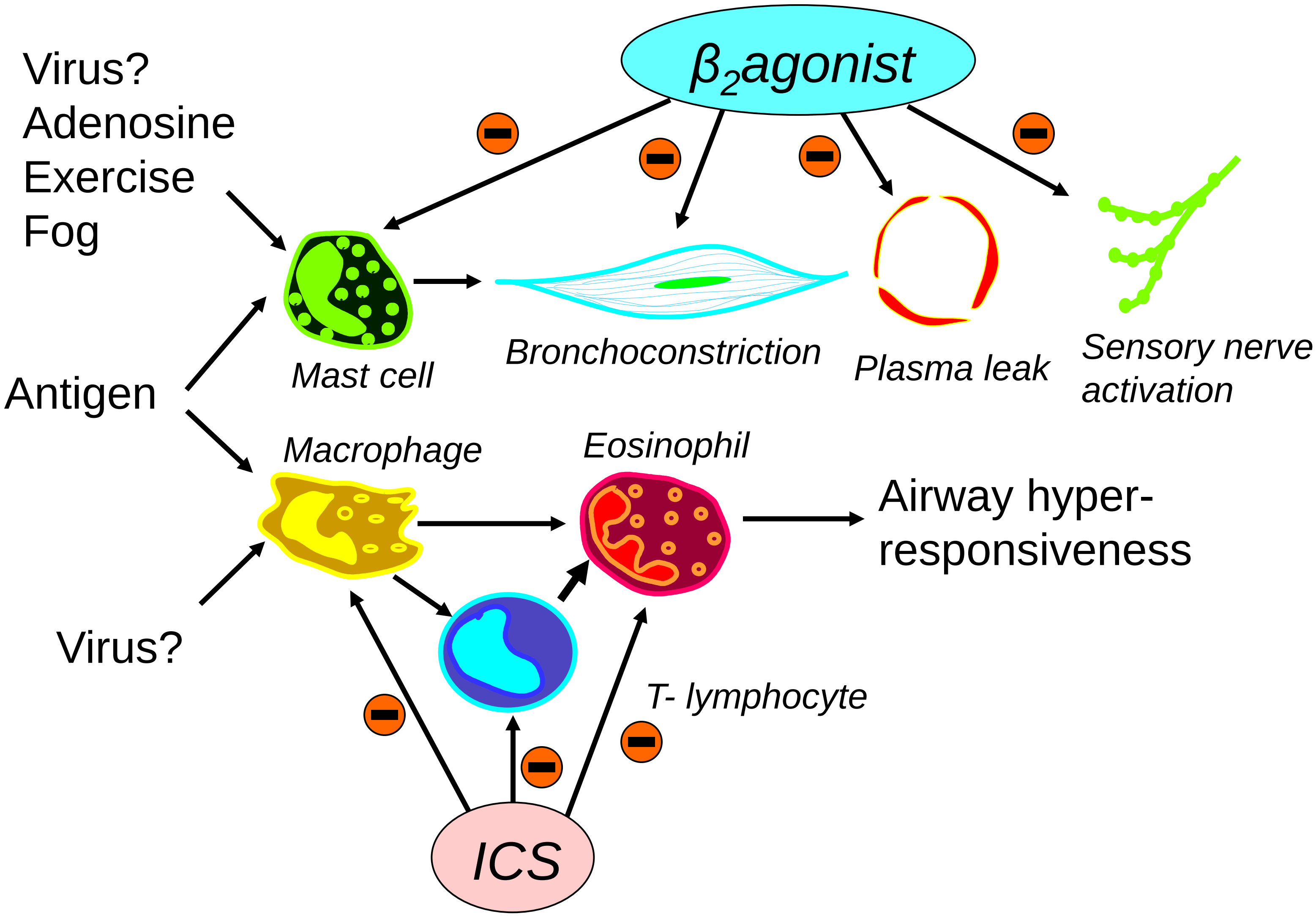
systemic corticosteroids

anti-IgE mAb (omalizumab)

anti-IL5 (benralizumab, mepolizumab, reslizumab), anti-IL4 (dupilumab), anti-IL13 (lebrikizumab, tralokinumab)

theophyllines

How it works?



$\beta_2$agonist
Virus?
Adenosine
Exercise
Fog
Antigen
Mast cell
Bronchoconstriction
Plasma leak
Sensory nerve activation
Macrophage
Eosinophil
Airway hyper-responsiveness
Virus?
T- lymphocyte
ICS

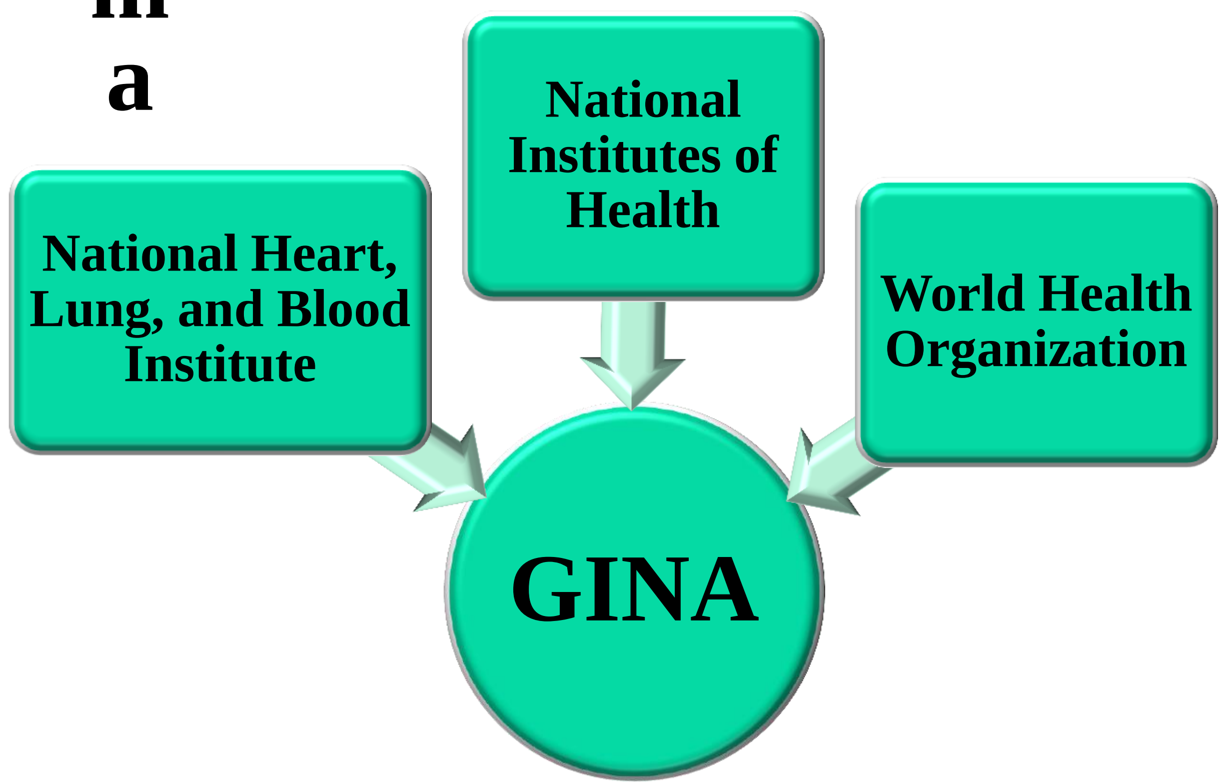

con simpatia

GINA

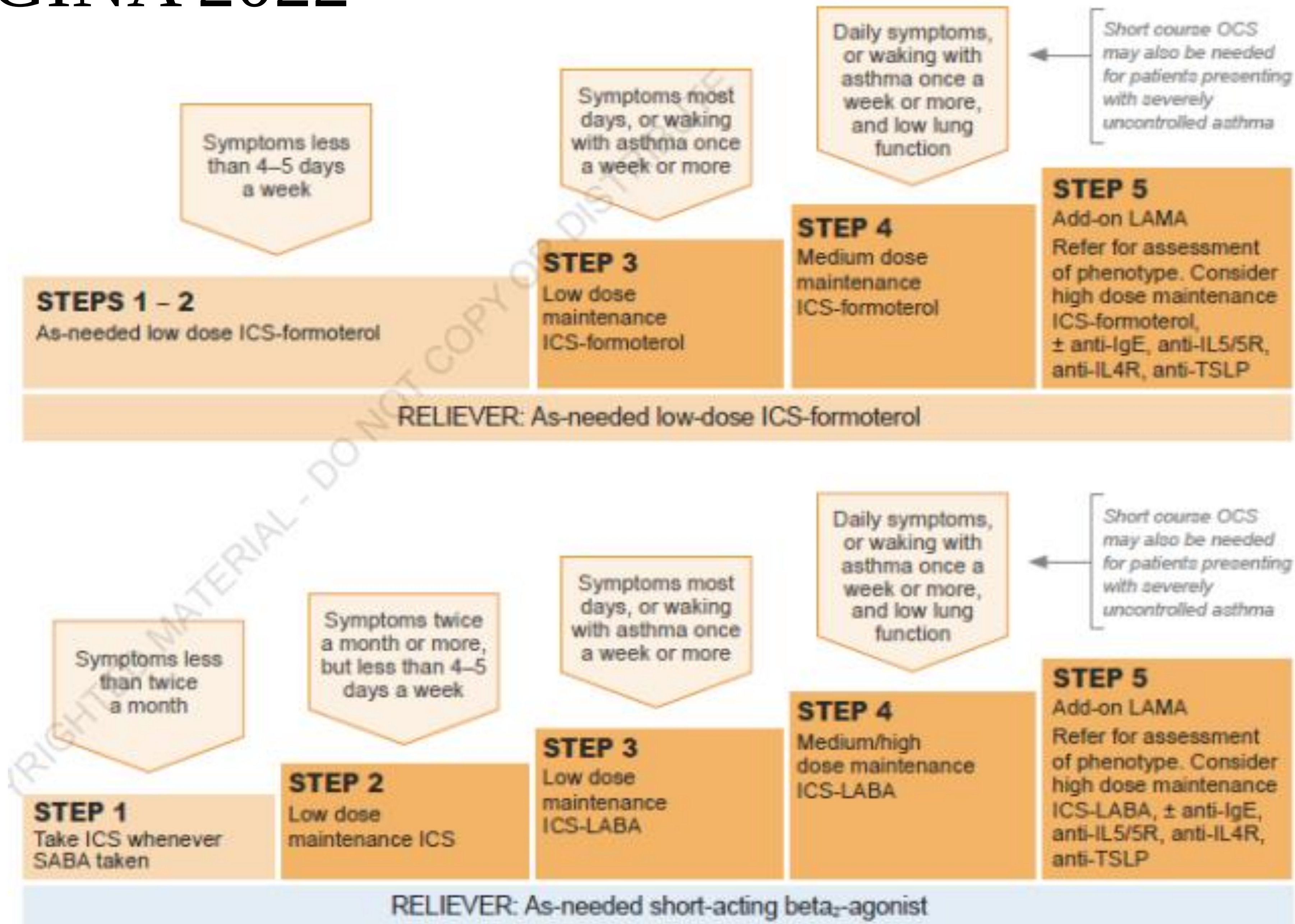
Global
Initiative for
Asthma

GLOBAL INITIATIVE FOR ASTHMA

Established in 1993



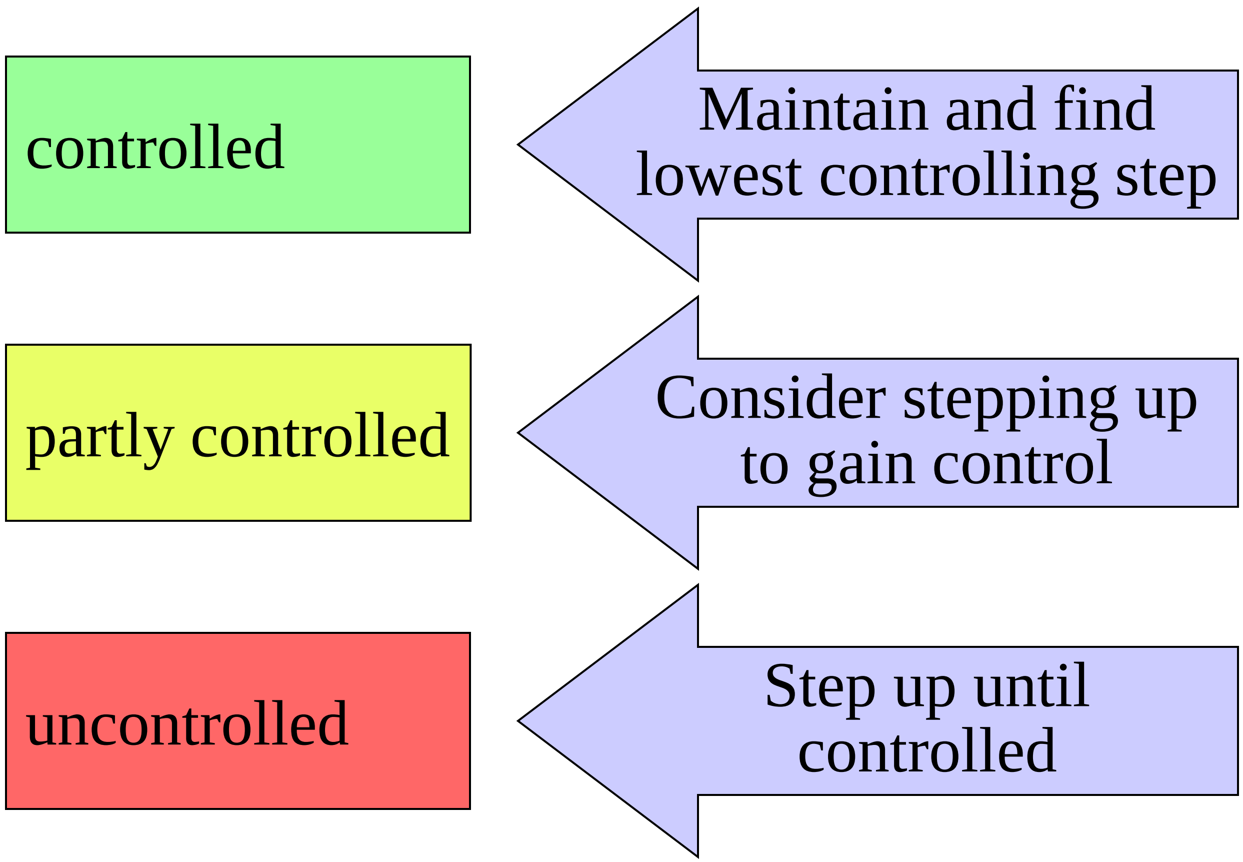
GINA 2022



Daily symptoms, or waking with asthma once a week or more, and low lung function
Short course OCS may also be needed for patients presenting with severely uncontrolled asthma
Symptoms less than 4–5 days a week
Symptoms most days, or waking with asthma once a week or more
STEP 5
Add-on LAMA
Refer for assessment of phenotype. Consider high dose maintenance ICS-formoterol, ± anti-IgE, anti-IL5/5R, anti-IL4R, anti-TSLP
STEP 4
Medium dose maintenance ICS-formoterol
STEP 3
Low dose maintenance ICS-formoterol
STEPS 1 – 2
As-needed low dose ICS-formoterol
RELIEVER: As-needed low-dose ICS-formoterol
Daily symptoms, or waking with asthma once a week or more, and low lung function
Short course OCS may also be needed for patients presenting with severely uncontrolled asthma
Symptoms most days, or waking with asthma once a week or more
Symptoms twice a month or more, but less than 4–5 days a week
Symptoms less than twice a month
STEP 5
Add-on LAMA
Refer for assessment of phenotype. Consider high dose maintenance ICS-LABA, ± anti-IgE, anti-IL5/5R, anti-IL4R, anti-TSLP
STEP 4
Medium/high dose maintenance ICS-LABA
STEP 3
Low dose maintenance ICS-LABA
STEP 2
Low dose maintenance ICS
STEP 1
Take ICS whenever SABA taken
RELIEVER: As-needed short-acting beta$_2$-agonist

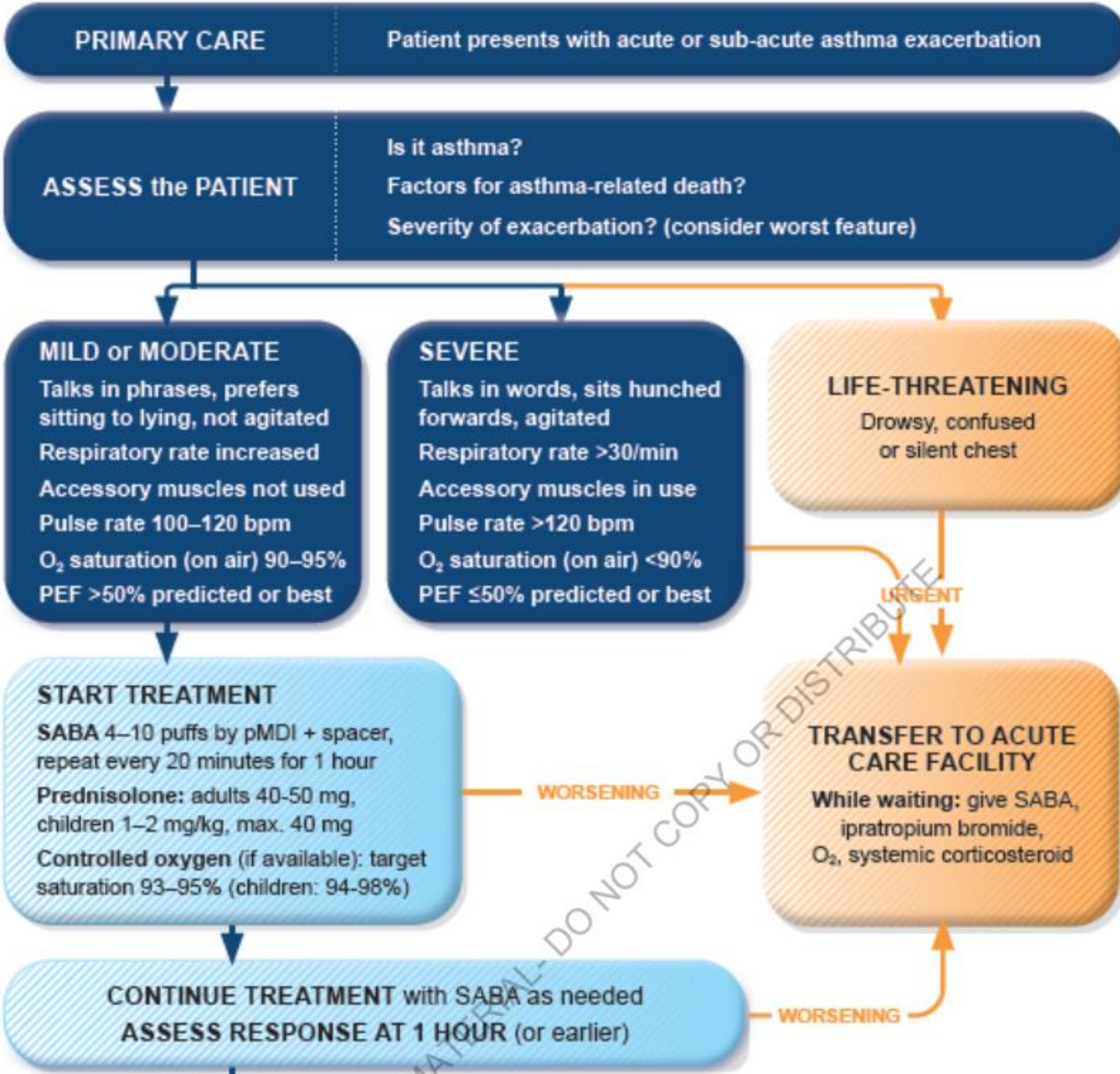
Asthma control

	controlled (all of following)	partly controlled (any)	uncontrolled
daytime symptoms	<3 times per week	>twice per week	>2 features of partly controlled asthma
limitations of activities	none	any	
nocturnal symptoms	none	any	
need for reliever	<3 times per week	>twice per week	
lung function	normal	<80% PV	
exacerbations	none	>=1 per year	1 per week


controlled
Maintain and find lowest controlling step
partly controlled
Consider stepping up to gain control
uncontrolled
Step up until controlled

Risk factors for poor asthma outcomes

- Medications: ICS not prescribed, poor adherence, incorrect inhaler technique, high SABA use.
- Comorbidities: obesity, chronic rhinosinusitis, GERD, food allergy, anxiety, depression, pregnancy.
- Exposures: smoking, allergens, air pollution.
- Setting: major socioeconomic problems.
- Lung function: FEV1<60%, higher reversibility.
- Labs: sputum/blood eosinophilia, high FENO on ICS.
- Ever being intubated or ICU for asthma, >1 exacerbation in the last 12 months.


PRIMARY CARE
Patient presents with acute or sub-acute asthma exacerbation
ASSESS the PATIENT
Is it asthma?
Factors for asthma-related death?
Severity of exacerbation? (consider worst feature)
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
SEVERE
Talks in words, sits hunched forwards, agitated
Respiratory rate >30/min
Accessory muscles in use
Pulse rate >120 bpm
O2 saturation (on air) <90%
PEF ≤50% predicted or best
LIFE-THREATENING
Drowsy, confused or silent chest
URGENT
START TREATMENT
SABA 4–10 puffs by pMDI + spacer, repeat every 20 minutes for 1 hour
Prednisolone: adults 40-50 mg, children 1–2 mg/kg, max. 40 mg
Controlled oxygen (if available): target saturation 93–95% (children: 94-98%)
WORSENING
TRANSFER TO ACUTE CARE FACILITY
While waiting: give SABA, ipratropium bromide, O2, systemic corticosteroid
CONTINUE TREATMENT with SABA as needed
ASSESS RESPONSE AT 1 HOUR (or earlier)
WORSENING

Patient education

- check the inhalation technique
- instruct in drugs dosage adaptation
- individual writen plan