

Occupational Asthma

Mechanisms, airway pathology, occupational assessment and prevention

Dr Abu Suraih Sakhri

MBBS, MD (Pathology)

www.abusuraisakhri.com

Learning objectives

Distinguish

Occupational asthma from pre-existing asthma exacerbated at work.

Explain

How occupational sensitizers and irritants generate airway obstruction.

Recognize

Inflammation, remodeling, and clinicopathologic manifestations.

Investigate

The work association objectively and identify exposure controls.

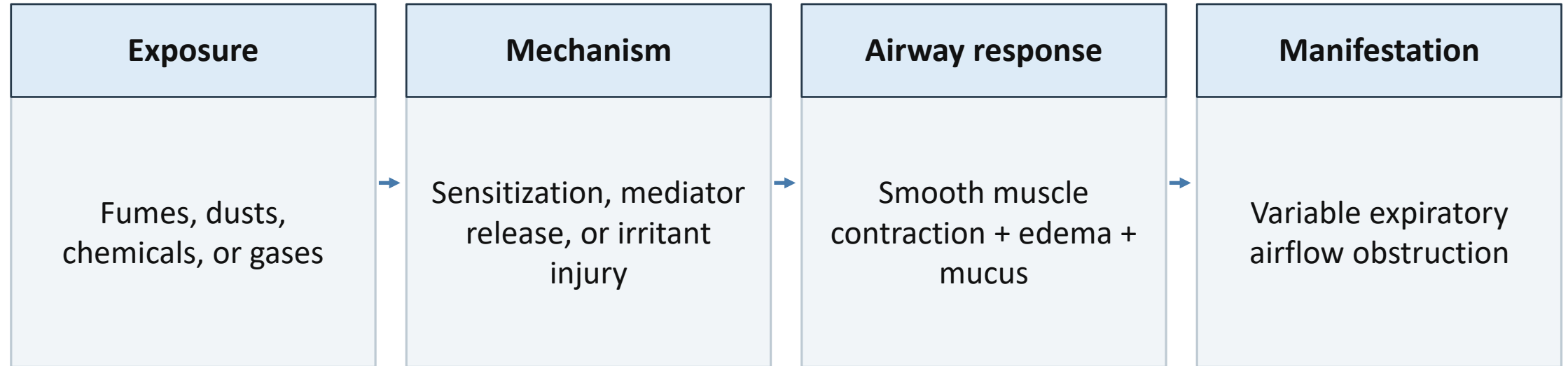
Asthma: The pathological foundation

- Chronic airway inflammation is accompanied by variable expiratory airflow obstruction.
- Wheezing, cough, chest tightness, and dyspnea vary over time and intensity.
- Airway narrowing reflects bronchoconstriction, mucosal edema, and mucus.
- Long-standing inflammation can produce persistent structural remodeling.

Two entities within work-related asthma

Occupational asthma	Work-exacerbated asthma
New asthma attributable to workplace exposure	Pre-existing asthma becomes worse because of workplace conditions
May arise through sensitization or irritant mechanisms	The workplace aggravates asthma rather than necessarily initiating it
Both demand careful exposure history and objective assessment	Both demand symptom control and reducing relevant exposures

From workplace exposure to symptomatic disease



Schematic — causal pathways vary by agent.

Robbins: Four occupational exposure groups

Fumes

Epoxy resins; Plastics

Dusts

Wood; Cotton; Platinum

Gases / vapors

Toluene

Other chemicals

Formaldehyde; Penicillin products

Representative textbook examples, not an exhaustive list.

Epoxy resin exposure: A source of fumes

- Fumes from epoxy resins as possible triggers.
- The implicated agent and exposure route must be established for an individual worker.
- Do not assume that every episode following fume exposure is IgE-mediated.
- Connect specific work tasks with the timing of new or worsening symptoms.

Plastics: Exposure is task-dependent

- Fumes associated with plastics appear' occupational trigger list.
- The term “plastics” spans different materials and processing conditions.
- A material inventory and task description are more informative than job title alone.
- Mechanistic attribution should not exceed what exposure testing establishes.

Specific agent
identification
requires
occupational
assessment.

Dust-associated exposures

Wood

Inhaled wood dust can be associated with asthma symptoms.

Cotton

The workplace history should distinguish asthma from other dust-associated diseases.

Platinum

Platinum among chemical or organic dust triggers.

A named exposure does not prove causation

- Finding dust or fumes in the workplace establishes possible exposure—not occupational asthma.
- Asthma must be demonstrated clinically and physiologically.
- A reproducible work association strengthens attribution.
- Competing causes or mimics still require evaluation.

Toluene and volatile exposures

- Toluene in its examples of occupational triggers.
- Workplace solvent use may produce inhaled vapor exposure.
- Symptoms should be tied to specific activities and ventilation conditions.
- An occupational agent list alone cannot establish an immune mechanism.

Other chemical triggers

Formaldehyde

A listed chemical associated with occupational asthma.

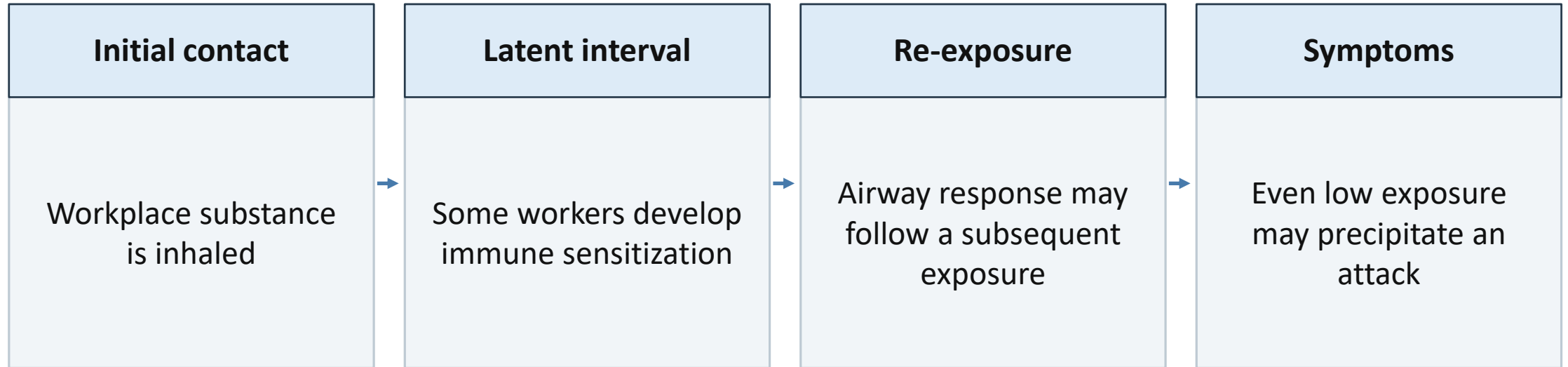
Penicillin products

A listed occupational pharmaceutical-product trigger.

Clinical question

Is the exposure associated with new asthma or merely worsening of established asthma?

Repeated exposure and sensitization



Robbins: Repeated exposure is usual; This is not a universal mechanism.

Very small quantities can provoke attacks

- Minute quantities of certain chemicals may precipitate an attack.
- This observation fits sensitization-associated reactivity after repeated exposure.
- The threshold cannot be inferred for an individual worker from the textbook.
- Low ambient levels do not necessarily imply safety for a sensitized worker.

Sensitizers and irritants: Different pathways

Sensitizer-associated	Irritant-associated
Typically follows a latency period before sensitization	Can reflect nonallergic airway injury
A specific immune response is implicated	May follow a high-level exposure without latency
Re-exposure may cause symptoms at low quantities	Gases, fumes, vapors, and aerosols are relevant irritants
Immunologic tests may help for some agents	Negative IgE testing does not exclude the mechanism

Sensitizer-associated asthma has a latency period

- An immunologic response develops after exposure begins.
- NIOSH describes a latency period commonly lasting at least several months.
- The worker may initially tolerate the environment without respiratory symptoms.
- After sensitization, subsequent exposures can trigger disease.

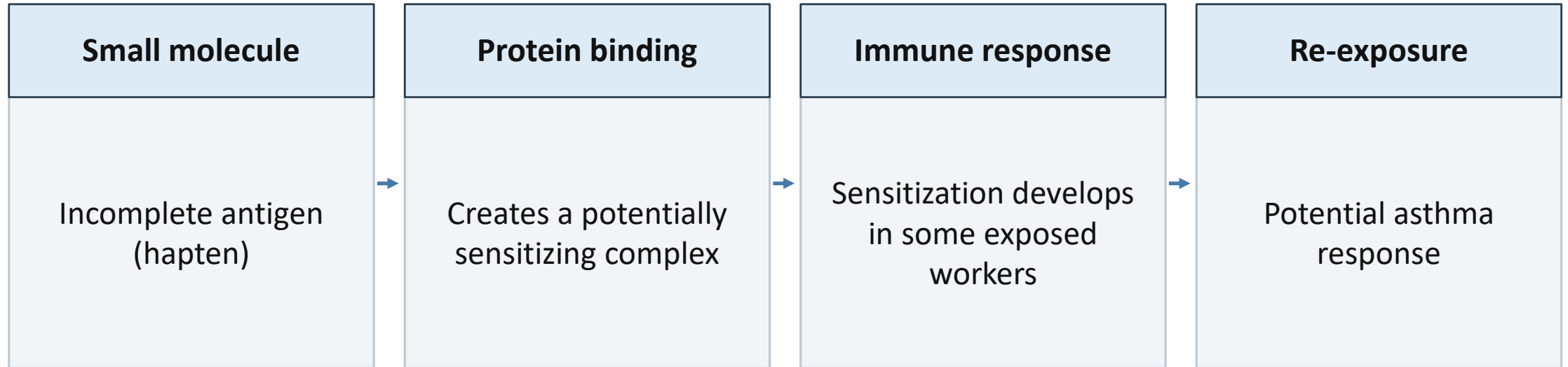
High-molecular-weight occupational sensitizers

- NIOSH examples include flour, grain and wood dust, latex, and plant proteins.
- Specific IgE antibodies can participate in the response.
- Re-exposure cross-links mast-cell-bound IgE and releases mediators.
- The diagnosis still requires linking the demonstrated asthma to work.

Low-molecular-weight occupational sensitizers

- NIOSH examples include diisocyanates, anhydrides, acrylates, and metals.
- Some substances act as haptens after binding to host proteins.
- An IgE test is not a universal diagnostic test for all low-molecular-weight agents.
- Mechanisms are heterogeneous and may not fit one allergic model.

Hapten-dependent sensitization: Conceptual model



Schematic: Applies to some low-molecular-weight agents; Not all occupational asthma.

Irritant-associated asthma is not necessarily allergic

- Irritant gases, fumes, and aerosols can produce nonallergic airway responses.
- The underlying biology is less well characterized than classic IgE-mediated asthma.
- An intense exposure may cause new-onset asthma without an immunologic latency.
- Distinguish irritant-induced disease from a pre-existing asthma exacerbation.

Latency clarifies exposure mechanisms

Feature	Sensitizer-associated	Irritant-induced
Typical exposure pattern	Repeated exposure	Can follow an intense episode
Latency	Usually present	May be absent
Mechanism	Immune sensitization possible	Nonallergic airway injury possible
Core proof	Asthma + work relation	Asthma + credible irritant exposure

Robbins: Occupational mechanisms are heterogeneous

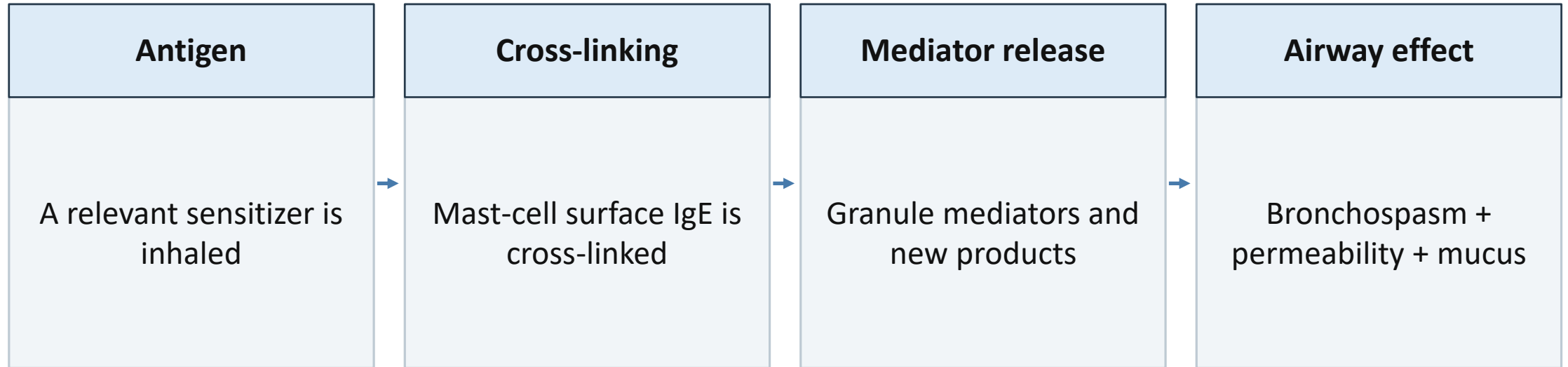
Type I reaction	Mediator release	Other hypersensitivity
IgE-associated immediate hypersensitivity in susceptible settings.	Direct liberation of bronchoconstrictor substances.	Responses of incompletely understood origin.

Avoid equating occupational asthma with atopic asthma in every patient.

Phenotype and trigger are separate dimensions

Atopic asthma	Nonatopic asthma	Occupational asthma
Evidence of allergen sensitization	No evidence of sensitization	Defined by causal workplace association
Frequently type 2 / IgE-driven	May involve infections or pollutants	Can involve immune or nonimmune processes
Categories are not wholly exclusive	Symptoms overlap	Exposure history becomes essential

IgE-mediated early response: Conditional pathway



Model applies when occupational asthma has a type I mechanism.

Th2 immunity: IL-4 promotes IgE production

- Th2 lymphocytes help coordinate type 2 airway inflammation.
- IL-4 promotes immunoglobulin E production by B cells.
- IgE can bind Fc receptors on mucosal mast cells.
- In a sensitized airway, antigen re-exposure may initiate a rapid reaction.

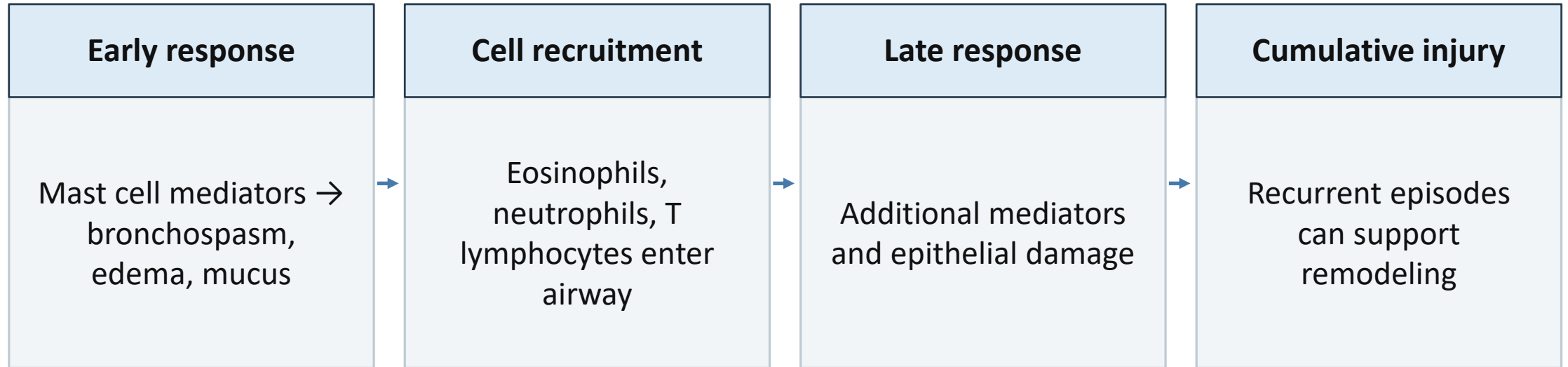
Th2 immunity: IL-5 recruits eosinophil effects

- IL-5 supports activation of recruited eosinophils.
- Eosinophils contribute to the late inflammatory reaction.
- Eosinophil products may damage airway epithelium.
- An eosinophilic phenotype is not mandatory in every occupational case.

Th2 immunity: IL-13 promotes mucus secretion

- IL-13 stimulates secretion from bronchial submucosal glands.
- It also contributes to the IgE-favoring type 2 response.
- Mucus increases the luminal obstruction caused by smooth muscle contraction.
- Excess mucus is one reason airflow obstruction can outlast the immediate trigger.

Immediate and late inflammatory phases



Inflammatory participants in asthma

Mast cells

Rapid mediator release after appropriate activation.

Eosinophils

Inflammation and epithelial injury in type 2 disease.

T lymphocytes

Cytokine-driven inflammatory coordination.

Neutrophils

Can dominate in a subset of severe disease.

Cysteinyl leukotrienes sustain bronchoconstriction

- Leukotrienes C₄, D₄, and E₄ can cause prolonged bronchoconstriction.
- They also increase mucus secretion and vascular permeability.
- Their role is supported by clinical effects of leukotriene antagonism.
- Multiple mediators contribute; There is no single universal asthma pathway.

Parasympathetic signaling narrows airways

- Acetylcholine released from parasympathetic nerves stimulates muscarinic receptors.
- Airway smooth muscle contraction reduces the airway lumen.
- Local and central vagal reflexes may contribute to the early response.
- This neural pathway can amplify inflammation-driven bronchospasm.

Three immediate contributors to airflow obstruction

Bronchoconstriction

Contracted airway smooth muscle reduces lumen caliber.

Wall edema

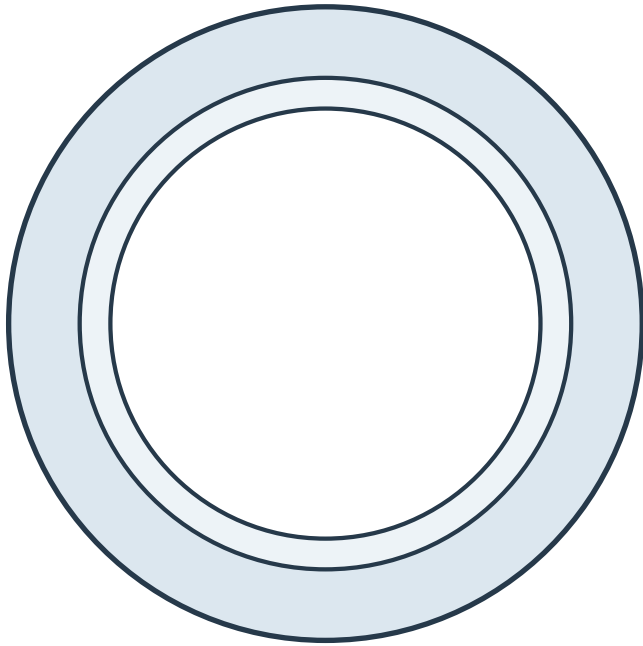
Inflamed, permeable vessels increase mucosal thickness.

Mucus

Viscous secretions occupy the already narrowed lumen.

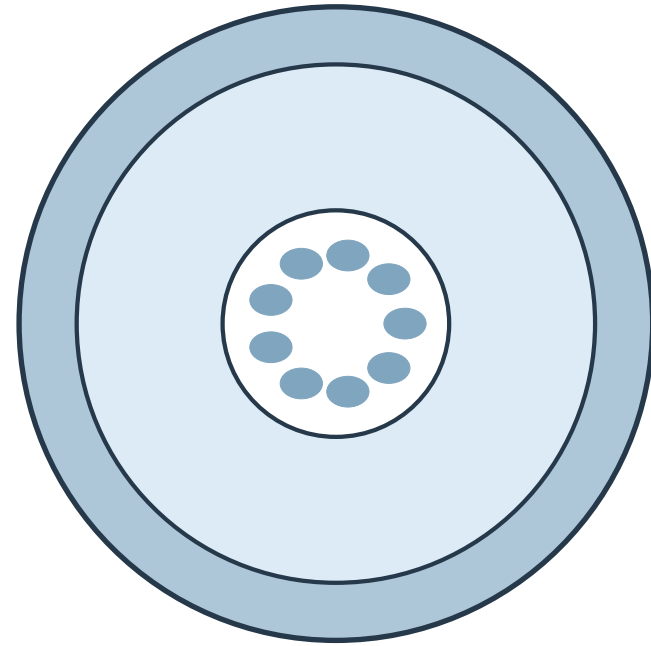
Healthy and asthmatic airway: Structural contrast

Uninvolved airway



Thin wall · broad patent lumen

Remodeled asthmatic airway



Thickened wall · narrowed lumen · mucus

Schematic; Not a patient specimen

Gross appearance in severe asthma

- The lungs may be overinflated during a fatal acute severe attack.
- Small regions of atelectasis may coexist with hyperinflation.
- Bronchi and bronchioles can be occluded by tenacious mucus plugs.
- These are established findings in asthma generally—not occupational-specific signatures.

Goblet-cell and mucous-gland enlargement

- Goblet-cell numbers increase within the airway epithelium.
- Submucosal mucus-secreting glands become enlarged.
- Excess mucus can accumulate inside narrowed conducting airways.
- Mucus burden increases airway resistance and impairs ventilation.

Sub–basement membrane fibrosis

- Collagens type I and III accumulate beneath the epithelial basement membrane.
- The airway wall becomes structurally thickened.
- This is a component of remodeling after chronic inflammation.
- Structural change can contribute to less fully reversible obstruction.

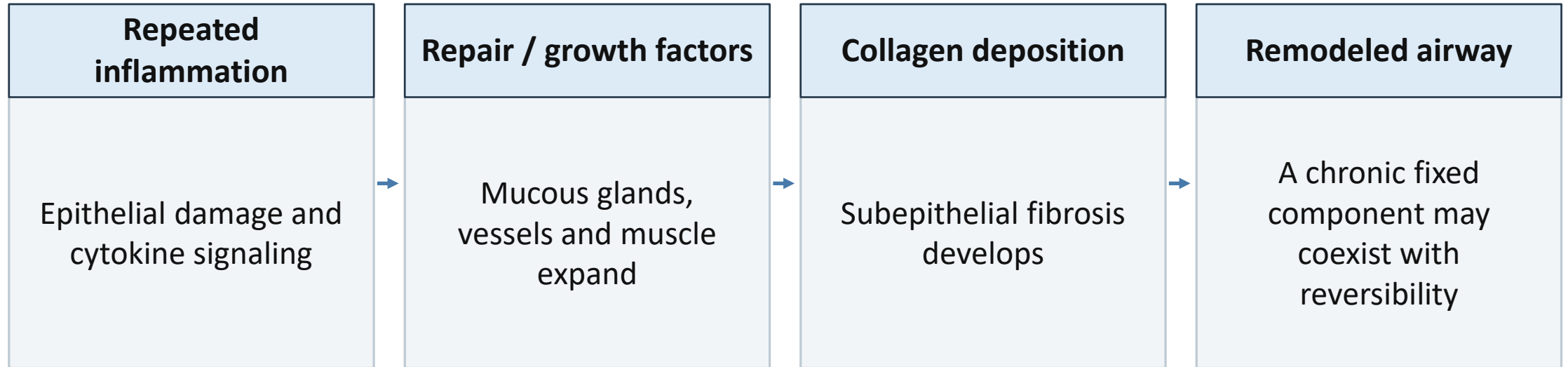
Smooth muscle hypertrophy and hyperplasia

- Airway smooth muscle mass increases in chronically remodeled bronchi.
- More muscular tissue thickens the bronchial wall.
- Muscular constriction still drives much of the acute airflow reduction.
- Together these changes contribute to increased airway responsiveness.

Increased airway vascularity

- Remodeled asthmatic airways can exhibit increased vascularity.
- Inflammatory vascular permeability also contributes to acute wall edema.
- Vascular alterations narrow the effective lumen indirectly.
- Separate chronic vascular remodeling from transient inflammatory swelling.

Why repeated attacks can leave persistent obstruction



Curschmann spirals and mucus plugs

- Curschmann spirals are twisted mucus structures in sputum or airway samples.
- They may result from extrusion of mucus plugs from small airway structures.
- They support an asthmatic inflammatory process in context.
- They cannot identify which workplace substance caused the disease.

Charcot–Leyden crystals: Eosinophil origin

- Crystals associated with eosinophils contain galectin-10.
- Them in sputum from atopic asthma.
- They may accompany mucus plugging and eosinophilic inflammation.
- Neither crystals nor eosinophils alone prove occupational causation.

Clinical manifestations resemble ordinary asthma

- Wheezing, cough, chest tightness, and shortness of breath are typical.
- Symptoms may fluctuate substantially between exposures.
- A worker may have normal examination findings between attacks.
- Clinical similarity makes occupational and nonoccupational asthma hard to separate without history.

Work-related symptoms may be delayed

- Symptoms can begin during an exposure or several hours after a work shift.
- Evening symptoms do not exclude a workplace trigger.
- Severe disease may persist on nonworking days.
- The full weekly pattern is more useful than asking about wheeze only at work.

Work association: Temporal clues

New job

Symptoms begin after employment or a change in work tasks.

New material

A new chemical or process precedes symptoms.

Time away

Symptoms may improve on weekends or holidays.

Return to work

Symptoms may recur or worsen after exposure resumes.

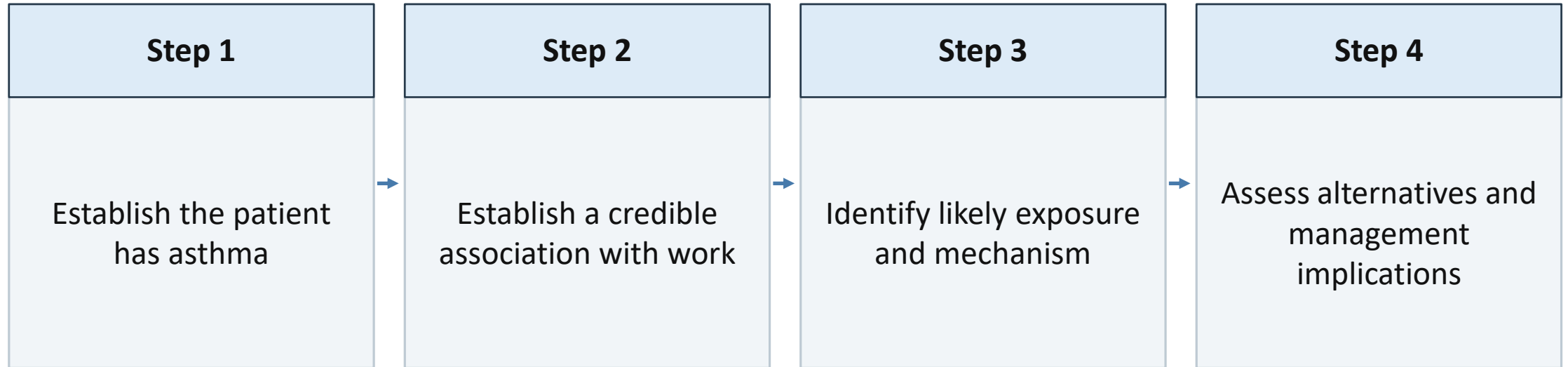
Occupational history: First-line clinical instrument

- Record current and previous jobs and detailed work tasks.
- Identify substances, dusts, gases, fumes, and process changes.
- Ask whether symptoms are better during weekends, holidays, or time off.
- Document onset timing relative to exposure and changes in medication use.

Exposure history: Ask about the task, not only the job

Question	Interpretive role
What material is handled?	Identifies candidate substances
How is it processed?	Highlights fumes, dust, or aerosol formation
When did the task begin?	Tests temporal plausibility
What happens away from work?	Screens for work association
Are coworkers affected?	May prompt workplace exposure assessment

Diagnosis requires two linked demonstrations



Symptoms alone are insufficient to identify an occupational cause.

Spirometry: Confirm variable airway obstruction

- Spirometry evaluates the degree of expiratory airflow limitation.
- Bronchodilator reversibility supports a diagnosis of asthma when obstruction is present.
- A normal test between attacks does not necessarily exclude asthma.
- Work causation requires additional exposure-linked evidence.

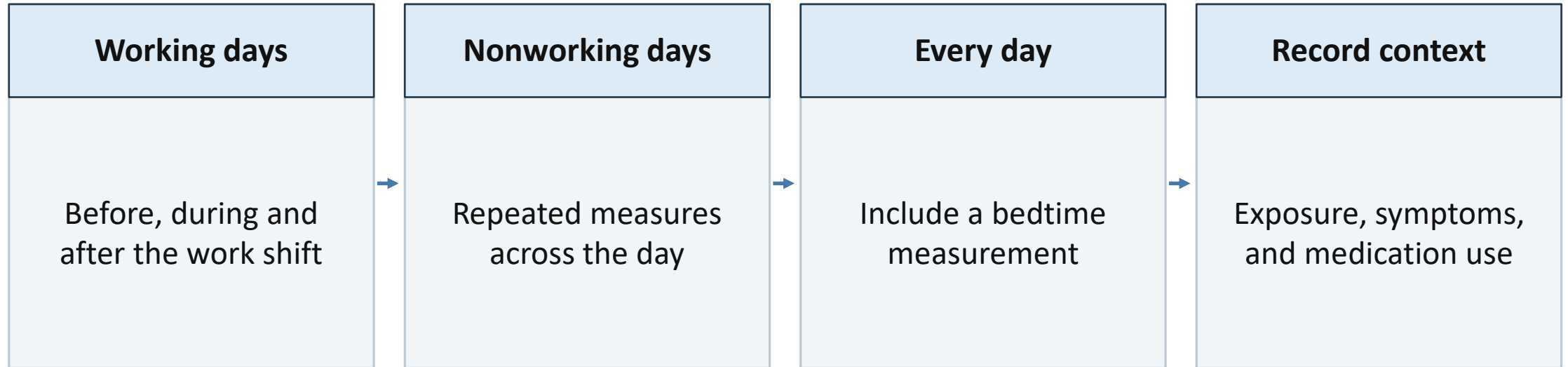
Bronchial challenge when baseline spirometry is normal

- If asthma remains suspected despite normal spirometry, bronchial responsiveness can be assessed.
- Methacholine or mannitol challenge are examples cited by NIOSH.
- Airway hyperresponsiveness supports asthma but does not alone identify the workplace cause.
- Testing decisions and interpretation belong to experienced clinicians.

Serial peak expiratory flow: Work versus rest

- Record repeated peak expiratory flow measurements during working and nonworking periods.
- Look for reproducible airflow differences associated with exposure.
- Measurements should span several weeks for interpretation.
- A short isolated cross-shift measurement can miss delayed or intermittent reactions.

A practical peak-flow diary schedule



NIOSH recommends four daily readings off work and serial workday readings.

Interpret a period away from work carefully

- Improvement in peak flow or bronchial responsiveness away from work supports association.
- Recovery may be incomplete or delayed in severe disease.
- Absence of a clear holiday effect cannot definitively exclude work-related asthma.
- Do not prescribe deliberate harmful re-exposure merely to demonstrate a pattern.

Specific IgE or skin testing: Limited scope

- Demonstrating sensitization can support an allergic mechanism for some agents.
- A positive test alone does not prove clinical occupational asthma.
- Many low-molecular-weight exposures lack straightforward immune testing.
- Negative allergy tests do not exclude irritant-induced or non-IgE disease.

FeNO measures inflammation, not workplace causality

- Fractional exhaled nitric oxide is a marker of allergic airway inflammation.
- An increased result does not distinguish occupational from nonoccupational asthma.
- A normal result does not rule out work-related asthma.
- Interpret biomarkers only as adjuncts to clinical and physiologic findings.

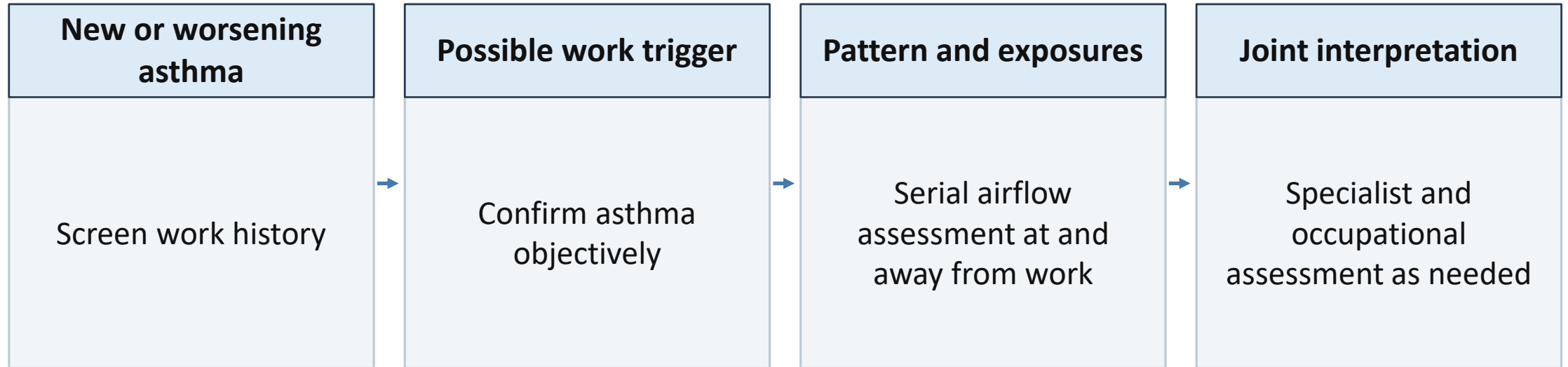
Specific inhalation challenge needs specialist oversight

- Controlled challenge may identify a causative agent when uncertainty remains.
- The procedure can provoke severe or delayed bronchoconstriction.
- NIOSH surveillance guidance confines it to experienced facilities with emergency resources.
- It is usually unnecessary for routine clinical diagnosis.

Key differential diagnoses in the working adult

Differential	Discriminating issue
COPD	Persistent airflow limitation; Competing exposures
Nonasthmatic eosinophilic bronchitis	Chronic cough without typical variable obstruction
Hypersensitivity pneumonitis	Predominant parenchymal rather than airway disease
Inducible laryngeal obstruction	Upper-airway symptoms may mimic wheeze
Obliterative bronchiolitis	Persistent small-airway obstruction

Integrated diagnostic reasoning



The pathway is an educational synthesis, not a substitute for guidelines.

Exposure elimination is a central intervention

- NIOSH identifies eliminating relevant exposures as the best approach.
- Exposure reduction through workplace controls may offer benefit.
- Individual restrictions or reassignment may be necessary.
- Continued exposure can undermine otherwise appropriate clinical care.

Clinical treatment and workplace prevention coexist

- Medical therapy addresses bronchospasm and airway inflammation.
- Workplace controls address the underlying exposure.
- Bronchodilators, glucocorticoids, and leukotriene antagonists among asthma treatments.
- Selection of therapy follows current asthma guidance and individual severity.

Workplace assessment: Actionable materials

- Request Safety Data Sheets for products and processes used.
- Consider industrial hygiene and occupational health consultation.
- Evaluate ventilation, work practices, and exposure controls.
- Maintain careful clinical documentation because job changes may have socioeconomic consequences.

Case 1: Epoxy-resin workshop

A worker develops episodic wheeze and chest tightness after months in a job involving heated resin mixtures. Symptoms recur after certain tasks and sometimes begin in the evening.

What mechanism and investigations should be considered?

Case 1: Reasoning from exposure to evidence

- The repeated-exposure interval makes sensitization plausible but not certain.
- Establish variable airway obstruction by spirometry or other objective testing.
- Document symptoms, tasks, and serial peak-flow patterns at and away from work.
- Identify the exact substance and involve occupational assessment.

Case 2: Flour-processing worker

A previously healthy worker develops cough and wheeze after prolonged employment in a grain-processing area. Symptoms often improve on weekends.

Which evidence would strengthen the diagnosis of sensitizer-associated occupational asthma?

Case 2: Distinguishing association from proof

- Flour and grain proteins are recognized high-molecular-weight sensitizers.
- The latency and work-rest pattern support a possible occupational connection.
- Demonstrate asthma and work-related change in lung function.
- Specific sensitization testing may be useful, but cannot replace objective assessment.

Case 3: A major fume release

An adult without a previous asthma history develops wheezing and chest tightness soon after an unusually intense accidental inhalation of irritant fumes at work.

Why should the clinician not require an allergic latency period?

Case 3: Interpret the acute exposure pattern

- High-level irritant exposure may produce new asthma without sensitization latency.
- Document the exposure, initial symptom timing, and persistent physiological abnormalities.
- Exclude mimics and distinguish from transient airway irritation.
- Avoid treating a presumed immune mechanism as established without evidence.

Four enduring diagnostic principles

Recognize

Consider workplace factors in any adult with new or worsening asthma.

Differentiate

New workplace-induced asthma is not the same as work-exacerbated asthma.

Demonstrate

Use objective respiratory testing and work-related serial measurements.

Prevent

Identify and eliminate the relevant exposure whenever feasible.

Selected source material

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Work-related taxonomy CDC/NIOSH. Information for Clinicians. Updated February 25, 2025.

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Exposure management CDC/NIOSH. Treating Work-related Asthma. Updated February 25, 2025.