4 Clinical History and Physical Examination of the Respiratory System

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Anamnesis

The clinical diagnosis of a respiratory disease begins with an interview to gather information pertinent to the clinical situation, which is then supplemented with a physical examination. In this interaction with the family and the patient, it is important, when appropriate, to develop a bond before proposing a deeper study plan and treatment that is realistic and in line with the family's expectations.

In the interview, the doctor must question all caregivers who can provide information, including the patient, if he or she is old enough. The doctor should ask about the main reasons for the consultation and proceed to characterize the manifestations and what repercussions they may have on the patient's daily activities such as playing, eating, or sleeping. During the interview it is important to ask open-ended questions that allow the parents to provide a broader description of the symptoms, which often reveal other hidden reasons for the consultation. Likewise, the doctor must supplement the interview with closed-ended and specific questions in relation to the symptoms, in order to precisely evaluate their relative importance, as well as any other relevant information.

The symptom or set of symptoms that have prompted the respiratory consultation are not always those most relevant to the child's health, but they show quite well the main concerns of the family. Thus, if in the course of the interview, very relevant symptoms appear that require consideration of the reason for the consultation, it is advisable to address the doubts that led the family to seek medical help in the first place.

Most respiratory symptoms are apparent in a regular patient interview, but it is always useful to look for symptoms that are not mentioned and are relevant to respiratory diseases. It is suggested to inquire about the following: cough, sneezing, coryza, fever, epistaxis, nasal pruritus, sputum, odynophagia, dysphagia, gagging, snoring, noisy

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breathing, dysphonia, wheezing, dyspnea, chest pain, hemoptysis, tachypnea, apnea, and cyanosis.

The duration of the respiratory symptoms makes it possible to characterize, in a simple way, those diseases that have less than a 4-week duration as an acute course, and those that exceed this period as a chronic course. This definition is extended to consider an intermediate subacute period of between 4 weeks and 3 months in adolescent children and young adults. If the symptoms are clearly discontinuous, with documented intervals of general well-being, the disease is recurrent. It is important to clarify this distinction for the parents, who often perceive that their child has a chronic disease, without realizing that the symptoms are actually intermittent.

When characterizing the symptoms, it is useful to describe the intensity with which they occur and the functional repercussion they involve. For example, an episode of cyanosis in a breastfed baby is just as serious for both the parents and the doctor because it implies an episode severe enough to completely compromise respiratory function. As a counterpart, parents can seek attention if the child has a persistent cough, which in the vast majority of cases will be attributable to a benign and self-limited cause. A set of symptoms and their frequency over time will be very valuable to classify a disease from mild to severe and from controlled to uncontrolled, as happens with asthma.

Part of the symptom characterization is the exploration of triggers and ways to alleviate the patient's condition. This is useful information in relation to daily activities, which are very clear for the caregiver, such as feeding, exercise, sleep, etc.

Feeding can be a triggering and/or worsening factor, from reporting of choking and cyanosis during swallowing of food to a persistent cough that worsens during feeding. When the voice acquires a wet tone it is suggestive of faulty swallowing, but a hoarse voice can also suggest glottic inflammation caused by intermittent tracheal aspiration. It is relevant to determine if the symptoms appear before, during, or after feeding, besides determining if their appearance changes according to the consistency of the food.

Exercise is a common triggering factor for cough, shortness of breath, and wheezing in many patients with hyperreactivity, especially during exercise in cold areas. Besides this, exercise increases cough in those who have persistent bronchorrhea and in those who have a running nose or sputum caused by a common respiratory infection; however, in the former patients the symptoms appear during exercise, while in the latter patients they appear later. Exercise may be good to quantify the importance of functional compromise in advanced diseases. In this case, the doctor should ask about dyspnea during minimal or little effort. The characteristics of the cough, as well as the strength of the voice, can also be considered, which will directly reflect inhalation and/or exhalation weakness. Playing, laughing, and crying in infants are considered the equivalent of exercise in older children. In newborns and young infants, feeding is an exercise that shows how tolerant the child is, considering how long he or she takes to finish feeding.

The child's sleep provides information about several symptoms. This happens mainly because of the supine decubitus position, but also because of the alternance between active and passive periods that every child has. Parents of newborns and young infants, whose children sleep often, may seek urgent medical care if there is apnea or if there is irregular or rapid breathing. In contrast, the parents of schoolchildren or adolescents who snore and present apneas many times consider this a normal finding, although it may reflect an obstruction of the superior airway. If there is a cough when the child goes to bed, it is possible that there are secretions in the posterior area of the pharynx or gastroesophageal reflux, but if there is no cough it is still relevant if there is no cough, it is still relevant to consider a possible diagnosis of a habit cough or psychogenic cough. If an infant has tachypnea or difficulty during breathing in the supine position, it can suggest diaphragmatic muscular weakness. This sign when the infant is sitting suggests chest muscular weakness. For the parents, an increase in respiratory frequency may not be clear, but they will describe "agitated" and "different" breathing. Clinical variations in symptoms between day and night may be evident in the clinical history, but they are not always caused by the child's position.

Sometimes, the explanation will lie in the air that the child breathes in the room while sleeping (e.g., the presence of contaminant heating, allergen exposure, etc.). Respiratory diseases tend to be related to environmental factors, and so a detailed description of the place where the patient lives in is very important. Most of the symptoms may worsen or persist when there is exposure to allergens or irritating inhaled agents such as those caused by industrial pollution or household pollution due to tobacco smoke, or contaminant heating involving burning of wood or paraffin. At the same time, there must be careful identification of seasonal and/or geographical changes that affect the symptoms, in order to discover possible triggers such as those related to the weather, altitude, etc. Respiratory symptoms that can be caused by respiratory infections—such as cough, fever, a running nose, or sputum, among others—make it necessary to ask about family members or people in usual contact with the patient who may also be affected. At this stage it is very important to note the order in which the different symptoms have appeared in the different patients.

The longer-term general history provides a good summary of the health condition of the child. Information from the pregnancy and the perinatal period is very important in relation to its consequences—for example, if the mother or the fetus suffered from infections or metabolic disorders, or if they were exposed to toxic agents such as nicotine. A stridor appearing during the first year of life may be caused by multiple factors, and knowing about the sequence of the events, and aggravating and alleviating circumstances, is the basis of a good diagnosis. The events that happened within this period—for example, neonatal asphyxia or recurrent seizures—may determine the persistent respiratory problems that the child may have afterward, such as a cough, sputum, choking, and wheezing. Growth during the first months of life is a good indicator of the health of an infant. If there is a lack of growth related to respiratory symptoms, this points to greater systemic compromise due to the disease.

There are many respiratory diseases that have a Mendelian genetic component (cystic fibrosis, alpha-1 antitrypsin deficiency, Duchenne's dystrophy, chronic granulomatous disease, etc.), caused by a mutation (Prader–Willi syndrome or cri du chat) or that are multigenic (asthma). This forces us to investigate the family history for at least two generations of every origin, with special attention to blood relationships and information about any infant deaths in the family. It is advisable to document the health of the direct family, including both parents and siblings.

Physical Examination

Inspection

Simple observation of the child during the interview and during the physical examination provides a lot of information. The first thing that must be observed is the respiratory pattern; this includes the respiratory frequency and rhythm, and the work of breathing. The respiratory frequency is a measurement taken routinely and must be interpreted as part of the physical examination. Because of the inherent variability that the rhythm of the respiratory cycle presents—which is heavily influenced by the state of alertness, besides the presence of pain or crying—it is important to measure a full minute of it instead of estimating it on the basis of a 30-second measurement. This is more important in newborns, in whom the presence of periodic breathing is common. There are reference tables for the respiratory frequency range and average at different ages, and these are very useful for global approximation of the breathing of a child (Table 4.1). Auscultation will corroborate the inspection or can be used to evaluate very superficial breathing. An increase in the respiratory frequency or tachypnea is nonspecific and appears in normal conditions such as crying, pain, fear, or as compensation for losses caused by anemia or hypoxemia, as well as conditions of reduced distensibility in the respiratory system and metabolic alterations. A reduction in the respiratory frequency or bradypnea is less common and difficult to perceive. It happens as a manifestation of central neurological or metabolic alterations. The respiratory rhythm varies greatly during the first months of life. In newborns, especially prema-

ture newborns, breathing is irregular, and they normally present a percentage of periodic breathing (apneas lasting <6 seconds in three bursts or more with alternate breathings separated by <20 seconds). After this period, the presence of periodic breathing is abnormal. Cheyne–Stokes respiration (cycles of increasing and decreasing work, separated by absence of breathing) is always an abnormal and infrequent finding in children with intracranial hypertension or heart failure. Biot's respiration (irregular and variable work cycles with absence of breathing) is a common finding and is characteristic of severe brain damage. Kussmaul's breathing, or acidotic breathing, is fast breathing along with an increase in chest incursion, which is very characteristic of metabolic alterations (Fig. 4.1.). Absence of breathing with flow stopping is called apnea and is always serious, no matter what context it appears in. Normal breathing work is reflected in synchronized chest and abdominal expansion, as exhalation takes place as a passive phenomenon at rest. Increased breathing work is reflected in the use of accessory muscles and chest wall retraction (Fig. 4.2). The infant may also present nasal flaring and sometimes an increase in the work when he or she goes to bed (orthopnea). The presence of paradoxical movement (thoracoabdominal asynchrony during inhalation) is a sign of severe and imminent compromise in relation to muscular fatigue in a child with respiratory distress, but it may also appear during sleep in schoolchildren or adolescents with obstructive sleep apnea, or sleep paralysis caused by medications used in surgery or endotracheal intubation. Subcostal retraction is easily visible in newborns, especially premature newborns, who have greater chest lung compliance than older children. Suprasternal retraction during inhalation is a sign of upper airway obstruction and is usually accompanied by hoarseness and stridor.

Asymmetry in chest expansion is difficult to perceive in infants, but it can be noticeable in older children who have pain and who manage not to move the affected side with greater flexion

Table 4.1 Respiratory rates in children by age

	Respiratory rate (percentile)								
Age	1	5	10	25	50	75	90	95	99
0 to <3 months	20	25	27	30	35	40	47	51	60
3 to <6 months	20	23	25	27	31	36	42	46	55
6 to <9 months	20	22	24	26	29	33	38	42	51
10 to <12 months	20	21	23	25	28	31	36	39	46
12 to <18 months	20	20	22	24	26	29	33	36	42
18 to <24 months	19	20	21	23	25	28	31	34	40
2 to <3 years	18	20	20	22	24	27	30	32	38
3 to <4 years	18	20	20	21	24	25	28	30	34
4 to <6 years	18	19	20	20	23	24	27	28	32
6 to <8 years	17	18	20	20	22	24	26	28	31
8 to <12 years	16	18	18	20	20	23	24	26	29
12 to <15 years	14	16	16	18	20	22	24	24	28
15 to <16 years	13	16	16	18	20	20	23	24	28

Modified from O'Leary et al. (2015)

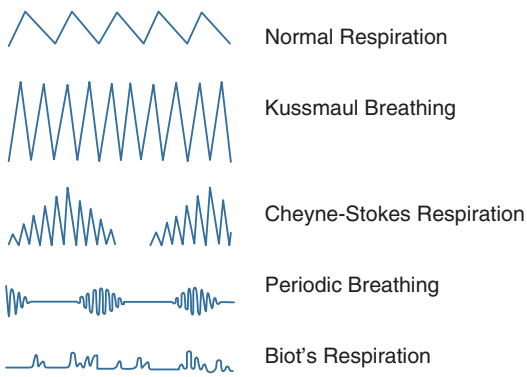

Fig. 4.1 Respiratory rhythm

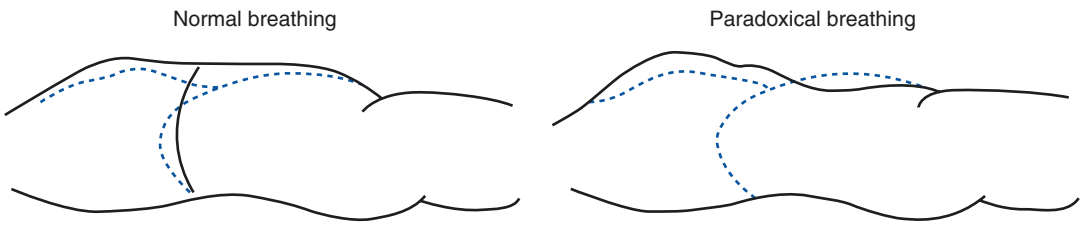

Fig. 4.2 Breathing synchronization

of the trunk. Evidence of the use of abdominal muscles at exhalation is a reflection of active breathing secondary to respiratory distress. In infants this mechanism may appear with glottic closure at the end of exhalation, which can be heard and is called a breathing grunt. In an infant with diaphragmatic paralysis, inhalation will cause a noticeable sinking of the abdomen when the infant is in the decubitus supine position, and there will also be asymmetry on the nonaffected side, which will sink when the infant is in the lateral decubitus position.

Chest dimensions may differ in different geographical zones and in different races. The chest undergoes a change from the newborn period, when it tends to be round, toward the school stage, when it acquires a flattened ovoid configuration when considered from the anteroposterior angle. A barrel-shaped chest in a teenager is a sign of chronic obstructive lung disease, which, in infants with severe bronchopulmonary dysplasia, manifests as a dove-shaped chest (Fig. 4.3).

A head and neck examination is useful to complement the respiratory diagnosis. Extremely obvious and characteristic findings in the facies of a child may determine the presence of craniofacial syndromes, as happens in Down syndrome, Apert syndrome, Crouzon syndrome, and CHARGE syndrome, among others. Usually, medial facial dysplasia in these children causes respiratory distress in the upper airway. The presence of purple skin under the lower eyelid, the finding of a fold in the skin of this zone (the Dennie–Morgan line), a transverse nasal crease under the bony section that is visible to the naked eye, or edema of the nasal mucosa, dry secretions, or abundant and aqueous rhinorrhea that unites the nasal septum and the turbinate (nasal bridges) on anterior rhinoscopy are all findings that are suggestive of allergic rhinitis. It is extremely useful to observe the nasal mucosa in a routine examination, because it can show purulent discharges, blood, polyps, and even foreign bodies. In allergic children, the presence of serum fluid can be confirmed by observation of the tympanum. With this technique the sequelae of recent infections can be controlled, such as when there is a perforation of the membrane or when there are plaques of tympanosclerosis. Inspection of the pharynx may show isolated malformations such as a palatine fissure or findings that are part of a syndrome such as macroglossia in a child with Beckwith–Wiedemann syndrome.

Opening of the oral cavity in a simple examination gives a hint if the airway is in a difficult condition (according to the Mallampati index), and it also reveals the proportion that the amygdules occupy; they are frequently increased in size in children who snore at night. Skin alterations are extremely relevant in respiratory diseases. For example, the presence of keratosis pilaris, pityriasis alba plaques, or eczema are all signs of atopic dermatitis. Pigmentation changes, light brown spots, and vascular tumors such as hemangiomas are indicators of diseases that may compromise the respiratory system. The most relevant skin sign that reflects respiratory compromise is cyanosis. When cyanosis appears, it means that the hemoglobin level is reduced (>5 g/dl) in the skin capillaries (distal cyanosis) or in the tongue and mucosal capillaries (central cyanosis). It tends to be an indicator of hypoxemia because of the presence of reduced hemoglobin, but it is clearly a poor indicator of hypoxemia when there is anemia, because in this situation a hemoglobin reduction large enough for cyanosis to become clinically evident rarely occurs.

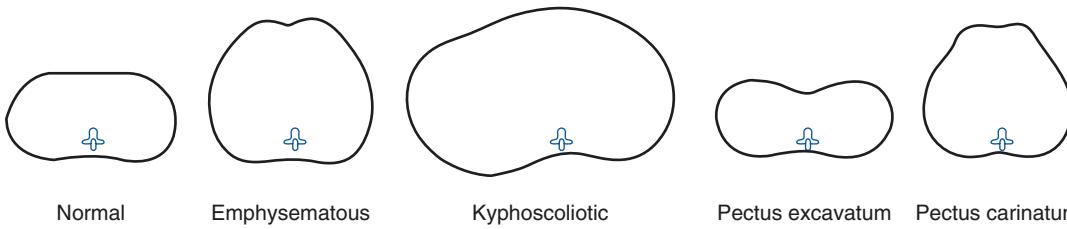

Fig. 4.3 Thoracic configuration

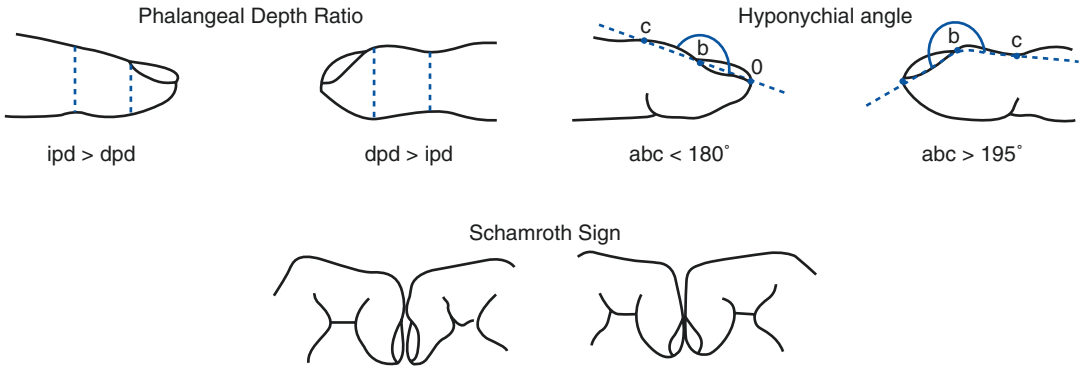

Fig. 4.4 Nail clubbing

The presence of digital clubbing is a nonspecific indicator of chronic lung disease, which is characteristic of cystic fibrosis, although it is also present in heart and gastrointestinal disease. It appears as a focal increase in the connective tissue in the distal phalanges of the feet and hands (Fig. 4.4).

The rest of the examination may contribute to the diagnosis of respiratory disease and is part of a good evaluation. Findings in the heart, abdominal, and limb examinations are especially important.

Palpation

Chest palpation is done at the same time as the inspection, and it follows a sequence that starts in the cervical area and ends in the abdominal area. At the neck it is important to notice any increase in volume or the presence of masses caused by adenopathies, growth of the thyroid gland, or hemangiomas and lymphangiomas. All of these structures may partially or totally occlude the upper airway and cause noisy breathing, stridor, and tracheal cough.

Anomalous positioning of the trachea may indicate related intrachest malformations. Palpation and soft pressure in the cricoid area can be used to trigger a cough in order to evaluate it. Chest palpation helps to find deformities, asymmetries of the costal structure, and areas where there is pain. Besides this, it is possible to perceive vibrations created by the voice when the child speaks out loud cries, in the case of infants. This technique is instinctively used by mothers to describe the presence of secretions in the lower airway, but the perception of "wet" vibrations in chest palpation does not necessarily have a localization. If air or fluid has entered the pleura, the transmission of these vibrations is reduced.

Percussion

The chest can be percussed because of its resonance, which is a consequence of its air capacity. Percussion in this area maintains the vibration, which is not softened, so the vibration resounds, and this is called "tympanic." When percussion is done in solid tissue, the vibration propagates quickly and is rapidly deafened, and this is called "dull." Percussion is done using the index finger over the distal phalange of the middle finger of the other hand, making equal and symmetrical movements, and then making comparisons. This technique shows the maximum lung excursion in the posterior wall of the chest, as well as the areas that should have a tympanic sound but where—because of fluid in the pleural space, or because of some peripheral consolidation in the lung parenchyma—a dull sound can be heard instead. When the sound of the chest is not symmetrical and increased, a pneumothorax must be considered.

Auscultation

The auscultation technique yields variable results depending on the conditions in which it is done. In order to improve sound perception, the child

must be calm and the environment must be quiet. Therefore, it is not unwise to start the auscultation when the baby is in the arms of the mother, before he or she starts crying out of fear. If the patient cooperates, it is desirable to have the patient sitting with his or her back straight in order to have the sound flowing normally. The number of areas that are evaluated during auscultation are variable, but at least three areas per side, anterior and posterior, should be considered. The breathing that shows more sound is deep breathing through the open mouth, with which the airflow is increased. Among infants, distraction and, in many situations, play can achieve this objective, although sometimes this includes only those sounds that are produced by sighing during crying. It is advisable to avoid the appearance of "artifact" sounds caused by forced breathing or affected by the phonation of the child.

The auscultation technique is based on bilateral comparison of sounds, but it also uses the intensity with which the patient may produce the sounds in different situations. In this way, it is possible to describe respiratory sounds as symmetrical or asymmetrical and as increased or reduced, according to the situation.

The respiratory sounds we hear during auscultation in the respiratory examination are caused by turbulence in the air in the central airway. The tracheal breathing sound is normally heard symmetrically above the jugular notch during the whole respiratory cycle. The tracheal sound has a wide spectrum (0–2000 Hz) and is enriched by the resonance of the area. The tracheal sound increases in intensity proportionally to the circulating flow, especially at high frequencies. In this way, when there is a narrowing at this level, the sound increases with the speed, which even allows us to perceive it at distance. Normal lung sounds can be heard on the surface of the chest and are well represented during inhalation but cannot be heard during exhalation. The lung sound has a lower frequency than the tracheal sound (0–500 Hz) because of the filtration—particularly in relation to the higher frequencies—that happens when air enters the lungs. The lung sound is produced in the primary and segmental bronchi during inhalation, and in the trachea during exhalation; therefore, it is affected by the convergence of the flow in the airway bifurcations. The lung sound of a child in the compared areas of the chest can be heard as being quite symmetrical but not precisely symmetrical, as there may be differences in the auscultation of both hemithoraxes. Sound transmission is very useful in abnormal situations. When passing through the airway, respiratory sounds are usually filtered, but in the presence of consolidation, their transmission improves and it is possible to hear a tracheal sound in lung areas (a tubular breath sound) and transmission of vocal sounds in a similar way (bronchophony), even during whispering (aphonic pectoriloquy). The terminology used to describe respiratory sounds has been reviewed recently, and an effort has been made to create universal terminology (Table 4.2). Adventitious breath sounds are extra sounds that occur besides the normal sounds specified for the respiratory disease.

Wheezing

Wheezing is a musical and continuous sound (lasting >250 milliseconds) that is produced when the airway vibrates in a narrowing area.

Table 4.2 Classification of breath sounds

Sounds
Breath sounds
Normal breath sounds
Laryngotracheal sounds
Lung murmur
Abnormal breath sounds
Noisy breathing
Tubular breathing
Decreased or absent lung murmur
Transmitted voice sounds
Normal sounds
Bronchophony
Egophony
Adventitious breath sounds
Continuous sounds
Rhonchi
Wheezing
Stridor
Discontinuous sounds
Crackles
Pleural rubs

The frequency of this oscillation depends on the vibrating mass around this airway but not on the diameter of the airway. Diffuse narrowing of the airway causes different wheezes with different or polyphonic tones. In turn, narrowing of the central airway creates wheezing in a similar or monophonic tone. Wheezing during exhalation shows narrowing of the airway and flow limitation, and these are the hallmarks of asthma and bronchiolitis. Wheezing shows frequencies close to 600 Hz, and some authors use the term rhonchus to refer to those frequencies close to 200 Hz, although they are also called low-tone wheezing.

Crackles

Crackles are discontinuous cracking sounds (lasting <20 milliseconds) due to the passage of air through the secretions of the airway, caused by sudden equalization of the gas pressure. Crackles can be fine or thick, depending on how long the sound lasts and its frequency. Fine crackles during the end of exhalation are common in active lung diseases. Fine crackles cannot be heard in the mouth, whereas thick crackles are transmitted through the airway and can be heard in the mouth.

Stridor

A stridor is a musical and continuous sound that is produced by vibration of the phonation system: the larynx, vocal cords, and adjacent tissues, as well as narrowing of the tracheal extrathoracic area. The sound can be heard with no instruments, mainly during inhalation, but as the obstruction continues, it may be audible throughout the respiratory cycle. The resonance spectrum of a stridor is very wide (200–1000 Hz), and it has a high intensity.

Grunting

A grunt is a musical and continuous sound caused by vibration of the vocal cords when they are closed forcibly and abruptly. In a similar way, snoring comes from vibration of the soft tissues in the pharynx, which causes a mixture of continuous and discontinuous low-tone sounds throughout the breathing cycle.

Pleural Friction Rub

A pleural friction rub is the only sound that is caused not by airflow but by the cuff of structures that are not smooth and are inflamed. It sounds like a discontinuous sound and it occurs in a symmetrical way during inhalation and exhalation.

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