

## Case reports

### The diagnosis of occupational asthma confirmed by serial peak expiratory flow rate monitoring

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#### Abstract

Occupational asthma, the most common occupational respiratory disease in industrialized societies, accounts for 5-10% of all cases of asthma diagnosed in the world. The number of cases is increasing given the development of the “consumer society”. We aim to discuss a case of occupational asthma that we have confirmed using internationally validated methods.

**Keywords:** *occupational asthma, the specific bronchial challenge test, Burge test*

#### Case presentation

In the emergency room, a 33-year-old woman is presenting with wheezing and severe dyspnea and polypnea that almost prevents her from speaking.

From the few anamnestic data, it results that it is the first time she has such manifestations. The symptoms suddenly appeared 2 hours before the presentation, worsening rapidly. They were preceded during the evening by a few sporadic bouts of dry cough.

The clinical examination shows an afebrile patient, with warm cyanosis of the extremities, with 30 superficial breaths/minute; AV = 100/min; BP = 90/60 mm Hg, chest almost fixed in deep inspiration,

uniformly hyper resonant; globally diminished vesicular murmur; without rales; no detectable heart dullness on percussion. The clinical examination does not bring other pathological elements.

Oxygen saturation (SaO<sub>2</sub>) 88% supports the clinical suspicion of respiratory failure.

After blood sampling for gasometry and blood chemistry, the oxygen therapy is instituted and the following medications are administered: hemisuccinate hydrocortisone 400 mg, acetylcysteine 600 mg, myophilin 240 mg in PEV (5% glucose 500 ml).

Ventricular rate (AV), respiratory rate (FR), blood pressure (BP), electrocardiogram (EKG) are

monitored.

Two hours after starting the treatment, the coloration of the skin and mucous membranes normalizes, the respiratory rate (FR = 20 breaths/min), and the ventricular rate (90 beats/min) are reduced, and the oxygen saturation increases to 96%.

Examination of the respiratory system shows the maintenance of hyper resonance and the appearance of wheezing and snoring rales spreading in both lung fields, predominantly anterior.

The blood gas balance at 2 hours shows the normalization of PaO<sub>2</sub> and PaCO<sub>2</sub>. Continued treatment with:

- hydrocortisone hemisuccinate 200 mg every 6 hours
- myophillin 240 mg every 12 hours
- O<sub>2</sub>-therapy.

Allowed by the improvement of patient's general condition, the anamnesis was resumed and revealed the existence within the last 4 years, of multiple episodes of dry cough associated with wheezing, which usually appeared at the end of the working day (symptoms related by the patient due to the fatigue caused by the working day) and watery rhinorrhea that occurred predominantly in the fall and winter (labeled and treated by the patient as a "colds"). It should be noted that the patient never went to see the doctor for this symptomatology.

The pulmonary radiograph performed showed only signs of hyperinflation, thus excluding the diagnosis of pneumothorax (which was the first suspicion of diagnosis).

What could have triggered acute respiratory failure?

### 1. neurological causes:

- central: stroke, drug intoxications (narcotics, sedatives)
- local: spinal trauma, poliomyelitis

**2. neuromuscular causes:** myasthenia gravis, tetanus, botulism, multiple sclerosis, intoxication with organophosphate insecticides

### 3. respiratory impairment:

- chest/pleura: pneumothorax, massive pleurisy
- parenchymal: pulmonary fibrosis, massive bilateral pneumonia
- upper airways: epiglottitis, laryngotracheitis, adenoiditis, tonsillitis
- lower airways: bronchiolitis, COPD, asthma

**4. cardiovascular:** acute cardiogenic pulmonary edema, pulmonary embolism, myocarditis

From these we exclude with the arguments we have at hand at this time:

- myocarditis - because the suffering is not accompanied by fever;
  - pulmonary embolism - the clinical examination of the lower limbs does not show signs of peripheral venous thrombosis nor atrial fibrillation;
  - acute pulmonary edema - due to lack of expectoration and absence of rales;
  - neurological and neuromuscular causes - by the lack of neurological and neuromuscular signs: reactive pupils, normal, symmetrical osteotendinous reflexes, as well as by the presence of pulmonary signs (hyper resonance, wheezing);
  - respiratory causes:
    - chest and pleural diseases are radiologically eliminated;
    - parenchymal diseases: pulmonary fibrosis is excluded based on clinical and radiological criteria due to the brutality of the patient's initial clinical presentation, namely acute and massive bilateral pneumonia;
    - upper airway damage is ruled out by the lack of fever, absence of intercostal retraction and stridor;
- The clinical picture is suggestive of lower airway involvement.

What would remain in question is the diagnosis of:

- Bronchiolitis obliterans, a diagnosis that is excluded by the following arguments: age, absence of fever, and absence of other infectious signs that preceded the current time.
- COPD - exacerbation: young patient, non-smoker, and absence of expectoration.
- Asthma - severe crisis???

After the patient's admission, the results of blood gas determination (Pa O<sub>2</sub> = 62 mmHg, Pa CO<sub>2</sub> = 42 mmHg) characterize the partial respiratory failure.

The working diagnosis was *RESPIRATORY FAILURE* probably of an obstructive cause, given the hypoxemia and the signs of hyperinflation.

Spirometry was performed 48 hours after hospitalization and 6 hours after the last administration of the medication when the patient was asymptomatic. Therefore the spirometric values obtained (Table 1), likely modified by the treatment administered, were less reflective of the initial pathogenic mechanisms that generated the illness.

The obstructive ventilatory disorder with significant reversibility to the bronchodilator (after administration of 400 micrograms of short-acting Salbutamol) was confirmed, although the patient was still under therapy with systemic corticosteroids and bronchodilators.

**Table 1.** Spirographic values

	Predicted Values	Actual Values	Bronchodilator Test
VC	3,47 L	3.06 L (88%)	3.13 L (+6%)
FVC	3,42 L	2.83 L (82%)	3.02 L (+7%)
FEV1	2,97 L/s	2,10 L/s (71%)	2.50 L/s (+19%)
FEV1/VC x 100	82,8 (±10,7)	68,6	77 (+12%)
PEF	6,81 L/s	3,77 L/s (55%)	4,57 L/s (+21%)
MEF50	4,30 L/s	2,08 L/s (48.3%)	2,67 L/s (+28%)

At this stage, spirometry data confirm and support the diagnosis of asthma.

She works as a modeler in a bakery, with a total work experience of 12 years and 8 months, in the same job; effective seniority 5 years in a first stage; interrupted the work for one year and six months for pregnancy and postpartum child care, returned to the same job 6 years ago. The work schedule consists of two 8-hour shifts with 30 workers per shift, with occupational exposure to flour powders, kneaders, molds, and other risk factors appropriate to the workplace (prolonged orthostatism, repetitive movements, unfavorable microclimate). All data was obtained anamnesticly and partially confirmed by the employer’s risk identification record sheet (flour powders, prolonged orthostatism). She does not smoke and is not a passive smoker; the house is sanitary; she has nothing significant to say about the heredocolateral antecedents; she has no history of atopy; she has a cesarean birth.

The anamnestic data obtained justified the hypothesis of sensitization to flour powder. However, the treatment performed in emergency prevented the investigation of the triggering factor of the disease at this time.

During the hospitalization, the patient’s evolution was good. She was discharged after six days, clinically and functionally improved (on discharge FEV1 76%, MEF<sub>50</sub> 54%) with the following recommendations:

- medical leave for 14 days
- background treatment with topical corticosteroids
- crisis treatment with short-acting beta-agonists, to be subsequently re-evaluated clinically and functionally to confirm or refute the professional diagnosis.
- she was recommended to monitor PEF during the

medical leave and 14 days at work

- reevaluation after 1 month when she will bring the recorded values to the PEF monitoring.

After 30 days the patient was readmitted according to the given instructions. The PEF values registered according to the recommendations were processed.

The records showed that between February 26 and March 11 (the period in which she did not work), the PEF variability was about 8%; while with the resumption of professional activity in the same job position, the variability was about 16%. (Figure 1) We note that the record was made under treatment and, therefore, it is plausible that the variability would have been much higher if the test was performed at the right time (respectively preceding the acute episode of bronchospasm that required hospitalization and medication).

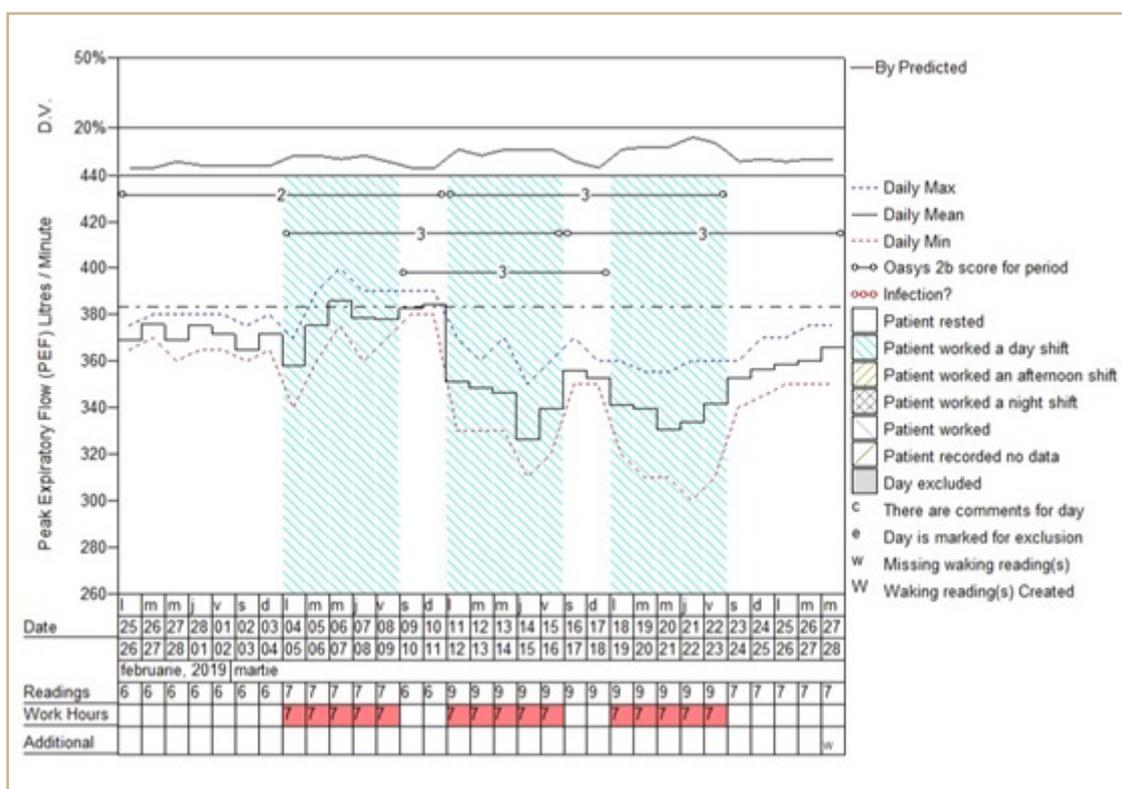
Changing this flow supports the broncho-obstructive effect of the occupational risk factors present at the workplace, as also supported by literature data [2].

Medication was discontinued and after 72 hours a conventional allergic assessment was performed:

- skin tests (prick-tests for common pneumoallergens: fungi, flakes, house dust, dermatophagoides pteronissimus, microbes) and existing occupational allergens at work - flour and dermatophagoides pharinae (DFP).

The tests came back positive for mites from the same family (DFP, dermatophagoides-pteronissimus - DFPh), as well as for powders from the same family (cereal powders and wheat flour) (Table 2).

After 24 hours, the specific bronchial challenge test (considered until recently the gold standard) was performed in the diagnosis of occupational asthma [3-5]. It is important for diagnosis, but also to validate the diagnostic accuracy of PEF monitoring.



**Figure 1.** The variability of PEF registered from February 25 to March 28

**Table 2.** Skin test results prick test

PRICK TEST	30 minutes
fungi	+
bird flakes	-
pollen	+/-
house dusts	-
dermatophagoides-pterionissimus	+
microbes	-
flour	+++
dermatophagoides pharinae	++
various cereals	++

The technique used was to fan the flour from one container to another for 30 minutes (wheat flour the patient brought from work). She was kept under observation and spirometry was done every hour. Approximately 2 hours after the end of the test, a respiratory picture was taking shape with bouts of irritating cough, wheezing, but without bronchial rales.

Spirometry performed at this time showed a significant decrease in expiratory flow values (Table 3), therefore this test, which partially reproduces the situation at work, with specific bronchomotor test value, was considered to be positive. A short-acting agonist and O<sub>2</sub> therapy were administered and the patient was monitored until the symptoms resolved.

**Table 3.** Spirogram – the specific bronchial challenge

	Base Values	POST CHALLENGE VALUES
VC	2,88 L	2,73 L (-6%)
FEV1	2,47 L/s	1,96 L/s (-21%)
FEV1/VC x 100	68,6	73,9
PEF	3,18 L/s	2,56 L/s (-19%)
MEF50	2,88 L/s	2,01 L/s (-30%)

Following the specific tests, we obtained the validation of the presumed diagnosis: **Occupational Asthma due to sensitization to flour powder.**

## Discussion

The argument for the diagnosis is based on the respiratory function panel, the identification of skin and nasal mucosa sensitization, history, and clinical data.

From the point of view of the respiratory functional picture, spirometry showed a variable obstructive dysfunction according to the evolutionary moment, but always with significant reversibility, and the controlled monitoring of PEF that showed important differences between the period when she was exposed to occupational allergens and the period in which she wasn't exposed; the specific bronchomotor test was positive.

The sensitization mechanism is objectified by the presence of eosinophils in the nasal secretions after the challenge test and skin sensitization to allergens at work.

The history of the disease, even if the manifestations were neglected by the patient, the clinical picture of hospitalization characterized as an episode of severe bronchial obstruction and data collected from the professional history of exposure and the existence of other cases of asthma at this workplace completed the diagnosis.

Upon discharge, recommendations were made for:

- cessation of exposure by changing jobs (in order to avoid triggers)
- administration of background treatment, according to the GINA guide [6]
- monitoring through the territorial occupational medicine office, the allergology and family medicine offices for periodic reassessment.

The occupational disease report was made by filling in the BP1 report form (the report is the responsibility of any doctor who establishes a diagnosis of occupational disease).

An important element that we brought into discussion is the confirmation of the usefulness of the Burge test (controlled monitoring of PEF: in two circumstances: during workdays and during the interruption of the activity) in establishing the professional diagnosis.

We compared in the case presented the diagnostic value of the two tests in a patient with known exposure and we confirmed that there is a good correlation in supporting the professional base of the

disease. Extrapolating, if we take into account the difficulty of performing the specific bronchomotor test, and the ease of performing the Burge test, we bring an argument for the choice of this test by the occupational physician.

The Burge test is a serial measurement of peak expiratory flow (PEF), the easiest test to confirm occupational asthma. Measurements must be made every 2 hours (minimum 6 measurements/day) during the waking period, both on working days (at work) and on days off. A correct, minimum record includes recordings made during two weeks at work and two weeks in a rest / medical setting [7].

The patient must be trained and cooperative. She will record daily: the time of awakening, the time of the first measurement (the hours of recordings must be kept constant throughout the monitoring period), the days off, the days she is at work and the treatment administered. The recorded values are most easily processed using an expert system for interpreting serial measurements of PEF (Oasys system) [7].

The test results are assessed by comparing the diurnal variation in working days (in L / min) with the diurnal variation in rest days. An increase [7] with a 15% variation in the workplace is considered a positive result [2, 8]; diurnal variability is calculated according to the formula maximum daily PEF-minimum daily PEF / average daily PEF [7].

This test is recognized as having high diagnostic specificity and therefore can successfully replace the specific bronchomotor test. Currently, an expert's assessment of chart records appears to be the most specific (94%) and sensitive (75%) method of diagnosis in occupational asthma [2].

For the occupational medicine physician, the test has a special utility in supporting the diagnosis of professionalism and for the situations in which asthma generating factors from the atmosphere at work are not identified [8].

The particularity of the case: it is obviously a case of allergic occupational asthma, with a latency period, characterized by specific bronchial hyperreactivity, which required a period of exposure not very long, less than 11 years of actual exposure, less than the average time required for flour sensitization. Flour is a weak allergen, which sensitizes slowly, in 10-15 years of exposure [9]. Producing immuno-allergic manifestations at a large number of occupational exposures (20-30%). The antigens themselves may be cereal powders, mites, and molds; they are high molecular weight proteins (over 5000 kDa) [10, 11].

It is worth highlighting for this case the lack of interest in investigating the respiratory function

and possibly bronchial hyperactivity at the time of employment, and during professional activity, by spirometry with bronchodilator test, in a workplace where high molecular weight allergens are present, as well as the delayed diagnosis.

The suspicion of occupational asthma is given by a history of asthmatic symptoms that improve on days off and vacation periods, and worsen at work, and to confirm professionalism serial monitoring of PEF is the key [2].

The diagnosis of occupational asthma requires the attention of the entire medical staff due to the high frequency and the socio-economic impact of the disease. The diagnosis of professionalism is not important for purely theoretical reasons, but especially for practical reasons related to the evidence that cessation of exposure improves the patient's quality of life on the one hand and prevents complications and asthma in a disabling disease.

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