Position Paper on Nasal Obstruction: Evaluation and Treatment

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Abstract

Nasal obstruction (NO) is defined as the subjective perception of discomfort or difficulty in the passage of air through the nostrils. It is a common reason for consultation in primary and specialized care and may affect up to 30%-40% of the population. It affects quality of life (especially sleep) and lowers work efficiency.

The aim of this document is to agree on how to treat NO, establish a methodology for evaluating and diagnosing it, and define an individualized approach to its treatment.

NO can be unilateral or bilateral, intermittent or persistent and may be caused by local or systemic factors, which may be anatomical, inflammatory, neurological, hormonal, functional, environmental, or pharmacological in origin. Directed study of the medical history and physical examination are key for diagnosing the specific cause. NO may be evaluated using subjective assessment tools (visual analog scale, symptom score, standardized questionnaires) or by objective estimation (active anterior rhinomanometry, acoustic rhinometry, peak nasal inspiratory flow). Although there is little correlation between the results, they may be considered complementary and not exclusive. Assessing the impact on quality of life through questionnaires standardized according to the underlying disease is also advisable.

NO is treated according to its cause. Treatment is fundamentally pharmacological (topical and/or systemic) when the etiology is inflammatory or functional. Surgery may be necessary when medical treatment fails to complement or improve medical treatment or when other therapeutic approaches are not possible. Combinations of surgical techniques and medical treatment may be necessary.

Key words: Nasal obstruction/nasal blockage/nasal respiratory insufficiency. Objective and subjective evaluation. Acoustic rhinometry. Rhinomanometry. Medical and surgical treatment.

Resumen

La obstrucción nasal (ON) se define como la percepción subjetiva de disconfort o dificultad en el paso del aire a través de las fosas nasales. Es un motivo de consulta frecuente en atención primaria y especializada, que puede afectar hasta un 30-40% de la población. Repercute en la calidad de vida (especialmente con alteración del sueño) y disminuye la eficiencia laboral.

El objetivo de este documento es consensuar el manejo de la ON, estableciendo una metodología para su evaluación y diagnóstico y un abordaje individualizado para el tratamiento.

La ON puede ser uni o bilateral, intermitente o persistente y debida a factores locales o sistémicos, ya sean anatómicos, inflamatorios, neurológicos, hormonales, funcionales, ambientales o medicamentosos. La anamnesis dirigida y la exploración física son claves para el diagnóstico diferencial. La evaluación de la ON puede realizarse con herramientas de valoración subjetiva (escala visual analógica, puntuación de síntomas, cuestionarios estandarizados) o por estimación objetiva (rinomanometría anterior activa, rinometría acústica, flujo máximo nasal inspiratorio). Aunque existe poca correlación entre ellas, sus resultados pueden considerarse complementarios y no excluyentes. También es aconsejable valorar el impacto en la calidad de vida mediante cuestionarios estandarizados.

El tratamiento de la ON se establece en función de la causa. Es fundamentalmente farmacológico (tópico y/o sistémico) cuando la etiología es inflamatoria o funcional. El tratamiento quirúrgico estará indicado tras el fracaso del tratamiento médico, para complementarlo o mejorarlo. Puede ser necesaria la combinación de varias técnicas quirúrgicas y/o la asociación de un tratamiento médico pre/post cirugía.

Palabras clave: Obstrucción nasal. Evaluación objetiva y subjetiva. Rinometría acústica. Rinomanometría. Tratamiento médico y quirúrgico.

Background and Objectives

Nasal obstruction (NO) is defined as the subjective perception of discomfort or difficulty in the passage of air through the nostrils. It is thought that this sensation is physiologically or pathologically generated in the trigeminal sensory receptors of the nasal mucosa. The terms obstruction and nasal congestion may be used as synonyms, although obstruction usually refers to the subjective sensation of irreversible blockage.

NO affects almost half of the population [1] and is one of the most common reasons for consultation in primary care, otorhinolaryngology, and allergology [2,3].

The condition can be caused by anatomical, inflammatory, neurological, hormonal, functional, environmental, and pharmacological factors. Furthermore, its etiology may be multifactorial, thus making diagnosis and treatment more complex.

NO is an annoying symptom that greatly affects quality of life (QOL), predisposes to and exacerbates lower airway diseases, alters night rest, decreases work efficiency, and aggravates sleep apnea [4,5].

Diagnosis of its specific cause is essential for selecting appropriate therapy. The enormous social and health care expenditure that it generates results from factors such as incorrect diagnoses and/or unsuitable treatment [6].

The objectives of this document are to reach agreement on management of NO and to establish a methodology for its evaluation, diagnosis, and treatment with the aim of enabling patients to breathe better through the nose.

Methods

This position paper on NO was drawn up using an iterative review methodology, whereby the sections of the document are drafted by groups of 2 or 3 people after which all the authors review, correct, and contribute to the whole manuscript.

To draw up the content of each section, the authors systematically reviewed the available bibliography using the OVID Medline tools and the Embase and Cochrane Review databases to select the best scientific evidence available on which to base the assertions and recommendations formulated in this document.

The quality of the scientific evidence and its risk of error were critically evaluated following the criteria of the Centre for Evidence-Based Medicine, Oxford, UK [7].

Epidemiology and Pathophysiology

NO is a symptom that is frequently reported by patients in primary care and otorhinolaryngology and allergy consultations [2,3,8]. Although there are no precise data, it is estimated that the condition may affect at least 30%-40% of the general population [1].

Indirect epidemiological data usually proceed from 2 sources: on the one hand, the number and frequency of functional nasal surgeries performed, which in some European countries ranges between 40 and 75 septoplasties per 100 000 inhabitants [2], and on the other, the presence of NO symptoms in sinonasal disease. In allergic rhinitis (AR), whose prevalence ranges from 10% to 40% [9], NO affects 80% of patients and is the main symptom in 50%-75% of cases [10]. Similar data are found in patients with nonallergic rhinopathy [10]. The prevalence of rhinosinusitis is estimated at 10% of the population [9], with NO at between 65% and 70% [9].

Physiologically, the nasal passages are both a sensory and respiratory organ. The anatomy of the nasal cavity is divided along the sagittal plane by the septum into 2 nostrils, of which the lateral wall includes the turbinates, which tend to adapt to nasal volume while increasing the mucosal surface. The limen nasi, or internal nasal valve, connects the nasal aperture with the nasal fossa and represents the narrowest area of the entire cavity. The nasal valve and turbinates are the main areas of resistance to airflow in the nasal passages, constituting 50% of

Table 1. Causes Of Nasal Obstruction (Unilateral and Bilateral) According to Age Group

	Cause of Nasal Obstruction	
Age Group	Unilateral	Bilateral
Children	Malformations Foreign bodies Benign or malignant tumors Unilateral chronic rhinosinusitis Antrochoanal polyp Septal deviation	Malformations Inflammatory or infectious rhinitis Chronic rhinosinusitis with or without polyps Adenoid hypertrophy Turbinate hypertrophy
Teenagers	Malformations Angiofibroma and other benign or malignant tumors Unilateral chronic rhinosinusitis Antrochoanal polyp Septal deviation Concha bullosa	Rhinitis of different causes (eg, allergic, hormonal) Chronic rhinosinusitis with or without polyps Malformations Adenoid hypertrophy Benign or malignant tumors Turbinate hypertrophy
Adults	Septal deviation Unilateral chronic rhinosinusitis Antrochoanal polyp Benign or malignant tumors Concha bullosa	Rhinitis of different causes (eg, allergic, pregnancy, medication) Chronic rhinosinusitis with or without nasal polyps Benign or malignant tumors Systemic diseases Turbinate hypertrophy Valvular insufficiency Empty nose syndrome

total resistance in the respiratory tree [11]. The vascularization of the nasal mucosa consists of at least 4 types of vessels with marked physiological relevance in nasal resistance [12]. The cavernous sinusoids are interposed between capillaries and venules, especially at the level of the turbinates. The endothelial layer is continuous, with a network of collagen and elastic fibers surrounded by smooth muscle cells whose activity enables the sinusoids to change volume rapidly depending on their state of blood congestion/decongestion [13]. The fossae and paranasal sinuses have complex sensory and autonomic innervation, with the control of secretions and vasodilatation being considered parasympathetic [14,15]. Local anesthesia or ablation of the sympathetic fibers inhibits the unilateral periodic engorgement of the mucosa responsible for obstruction, which is characteristic of the nasal cycle [16]. The neural mechanisms that control vascular flow and nasal congestion are unknown [17].

NO is produced by all those causes that hinder airflow through the nostrils and may be unilateral or bilateral (Table 1). It is caused either by inflammation of the nasal mucosa or by an anatomical abnormality that hinders flow, both of which result in a narrowing of the nasal cavity and a subjective sensation of blockage or nasal congestion [18]. Inflammation of the sinonasal mucosa is the central pathophysiological mechanism of most of the factors that contribute to NO, such as venous engorgement, increased nasal secretions, and tissue edema. These factors are seen mainly in disorders of the upper respiratory tract such as AR, nonallergic rhinitis (NAR), chronic rhinosinusitis (CRS) with or without nasal polyposis (NP) [19], systemic vasculitis, and even as an adverse effect of some drugs. Mechanical and/or structural anatomical abnormalities of the nasal cavities are also an important cause of NO. These include septal deviation, nasal valve insufficiency, turbinate or adenoid hypertrophy, choanal atresia, middle turbinate pneumatization, neoplasms, and the presence of foreign bodies. In some patients, there is increasing evidence of the involvement of a neurogenic signaling mechanism that causes the sensation of NO in the absence of real obstruction of the nasal passages [20].

Medical History and Clinical Examination

Medical history and physical examination are the basis for drawing up a proper diagnostic-therapeutic plan for NO [21].

Medical History

NO is the major symptom of a broad spectrum of diseases [22], and, before a suitable, specific diagnosis can be made, it must be characterized by taking a focused medical history including the following:

- Onset: acute or chronic, and progress.
- Laterality: unilateral (suggests structural causes or foreign body in children; if NO progresses, sinonasal tumor must be suspected) or bilateral (suggests inflammation of mucous membranes).
- Duration of symptoms: intermittent or persistent. Assess alternation, annual seasonality, and diurnal variability (work, home, physical activity) and nocturnal variability (worsens in decubitus or sleeping on one particular side), which suggest an inflammatory or functional cause.
- Disease severity: severity of symptoms using a visual analog scale (VAS) [23] or questionnaires that evaluate NO, such as the Nasal Obstruction Symptom Evaluation (NOSE) [23] or the Congestion Quantifier Seven-Item

Test (CQ7) [24], which has been validated for the Spanish population.
- Effect on QOL: specific questionnaires for sinonasal disease.
- Triggers: allergic, physical or chemical stimuli, infections, injury, surgery, pregnancy, environmental-professional, changes in usual medication (any drug or biological process [eg, pregnancy or hypothyroidism] that directly or indirectly leads to a predominance of the parasympathetic system will cause NO).
- Nasal symptoms: Pruritus, sneezing, and rhinorrhea are associated with inflammatory or infectious conditions; pain, hyposmia/anosmia, and thick rhinorrhea are associated with sinonasal disease; anatomical deformity and epistaxis suggest an aggressive etiology.
- Comorbidities: In patients with rhinitis, the presence of asthma [25], conjunctivitis, CRS, pharyngeal symptoms, visual disturbances, nervous dysfunctions, or systemic symptoms suggestive of vasculitis should be assessed.
- Personal history: Data should be gathered on history of atopy, exposure (allergenic, occupational, or irritant), trauma, nasal surgery, recurrent sinusitis, rhinitis/asthma caused by nonsteroidal anti-inflammatory drugs, obstructive sleep apnea, cystic fibrosis, hypothyroidism, pregnancy, chronic infectious diseases (syphilis, leprosy, tuberculosis), systemic vasculitis (Wegener disease and Churg–Strauss syndrome), and malignant vasculitis [26].
- Drugs and substance abuse: Record the use of intranasal decongestants, regular medication that can influence obstruction (antithyroid drugs, antipsychotics, antihypertensives, oral contraceptives, antidepressants), cocaine, and tobacco [27].

Examination

When compiling the medical history, we must note any indirect signs such as constant oral breathing, rhinolalia (open or closed), and allergic salute.

- Inspection. Assess the appearance of the nasal skin, protrusions, asymmetries, or lateralization of the cartilaginous and/or bony nasal pyramid. Record dynamic or static nostril collapse in inspiration and columellar anomalies such as asymmetry or dislocation of the quadrangular cartilage over the columella.
- Palpation. Palpate sinus points (supraorbital, infraorbital, Ewing, or ethmoidal), to assess whether it triggers pain or crepitus. In the bone and cartilaginous pyramid, note asymmetries, crepitation, lack of support, or subsidence. Assess alignment and consistency in the anterior septum and columella.
- Anterior rhinoscopy: The rhinoscope (or otoscope in children) enables us to assess the anterior third of the nose (Cottle areas 1 and 2, and part of the third) [28], which includes the most caudal region of the septum, the nasal valve, and the head of the inferior turbinates. Sometimes the head of the middle turbinate and the cavum may be observed. The nasal mucosa should be evaluated for pink and moist appearance (normal), signs of atrophy/dryness (dry rhinitis), scabs (vasculitis or chronic atrophic rhinitis), congestive mucosa (rhinitis and/or rhinosinusitis), and pale mucosa (allergic or drug-induced rhinitis). Investigate the presence of deviations, synechiae, perforations, and rhinorrhea and their characteristics. In the case of turbinate hypertrophy it is very useful to observe permeability and appearance after administering a topical vasoconstrictor. It is very important to detect occupation of the nasal passages either bilaterally (polyps) or unilaterally (tumors).
- Posterior rhinoscopy. This approach has fallen into disuse with the generalization of endoscopy.
- Nasal endoscopy (rigid or flexible): Provides a detailed examination of the nasal passages [21]. The optic device is introduced along the inferior meatus to visualize the cavum and then progressively retracted to assess the

Table 2. Cottle Areas and Their Limits (Modified From Zambetti et al [28])

	Limits of the cottle areas			
	Superior	Inferior	Medial	Lateral
Area 1: Vestibule (0.5 cm)	The alar cupula, the rear junction of the triangular cartilage and piriform orifice	Recess limited by the cupula of the alar cartilage	Nasal septum	Alar cartilage and the medial wall of the nasal ala
Area 2: Valve (1.5 cm)	Lower extremity of the triangular cartilage	Lower margin of the piriform orifice Anterior and premaxillary nasal bone	Nasal septum	Fibrofatty tissue extending to the piriform aperture
Area 3: Attic (2.5 cm)	Naso-frontal suture	Upper lateral cartilage partially covered by nasal bones (area K)	Nasal septum and contralateral nasal bone	Naso-frontal apophysis of the maxilla
Area 4: Anterior turbinate (3.5 cm)	Anterior portion of the anterior nasal wall, including the turbinate Medially, septal cartilage			
Area 5: Posterior or choanal turbinate (6 cm)	Posterior portion of the turbinates towards the choana Medially, the corresponding portion of the perpendicular lamina of the ethmoid and the vomer			

superior and middle turbinates and meatus. The presence, size, and laterality of septal deviations should be noted, as should any polypoid tumor masses and the presence of rhinorrhea in the 5 Cottle areas (Table 2 [28]).
– Functional maneuvers for exploring the nasal valve: explore collapse in forced inspiration [29]. The best known is the Cottle maneuver, which allows the angle of the valve to be increased [30].
– Examination of the remaining area (ear, nose, throat). Perform otoscopy and oropharyngoscopy. Laryngeal and pulmonary exploration depend on the patient's medical history. Given the high prevalence of comorbidity, it is very important to study the lower respiratory tract.

Subjective Evaluation of NO

NO can be evaluated subjectively by the physician using a Likert-type scale and by the patient using patient-reported outcomes based on a VAS or questionnaires that assess the effect of NO (NOSE, CQ7).

The VAS has been used to subjectively assess all nasal symptoms, including NO. A horizontal 10-cm line is scored by marking it with a vertical line at the place where the patient considers that it best indicates the intensity of the symptom, from 0 to 10. The left end (0) indicates the absence of NO and the right end (10) the maximum severity of NO (Figure 1).

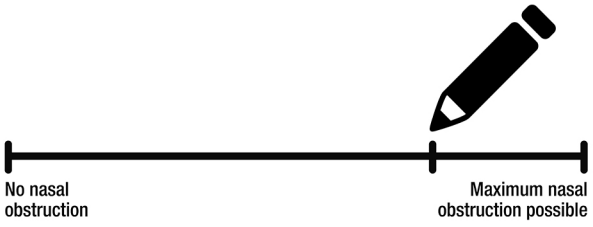


Figure 1. Visual analog scale for nasal obstruction.

The VAS is a well-studied tool for assessing the severity of NO and has been validated with reference to other subjective measures such as symptom score [31] and to objective measures such as rhinomanometry (RMN), acoustic rhinometry (AcR), and peak nasal inspiratory flow (PNIF) in adults [32,33] and nasal endoscopy in children [34]. It has been estimated that, in asymptomatic individuals, the mean VAS value used to assess NO ranges from 2.1 (2.2) to 4.6 (2.6) in the general population [23].

With the nasal symptom score, the intensity of symptoms is evaluated using a Likert-type scale, for example, from 0 to 3, where 0=no symptoms, 1=mild symptoms, 2=moderate symptoms, and 3=severe symptoms. The Likert scale score on NO has been validated by comparing it with the VAS and AcR [31].

Questionnaires to Assess the Impact of NO

– NOSE. This questionnaire was designed to measure how NO affects QOL. It was initially designed for patients with septal deviation and contains 5 items rated using a 5-point Likert scale ranging from 0 (not a problem) to 4 (a serious problem), with the result expressed over a maximum of 100 by multiplying the sum of the answers obtained by 5. The questionnaire has been translated into Spanish and validated, its psychometric properties are sufficient, and it is closely correlated with the VAS [35]. It has been estimated that the NOSE questionnaire yields a mean value of 15 (17) in the asymptomatic individual and 42 (27) in the general population [23].
– CQ7. This tool was designed to identify patients with nasal congestion and displays good psychometric characteristics and the ability to discriminate between different levels of severity of AR symptoms [24]. It consists of 7 questions rated on a scale of 0 (never) to 4 (always), with a score range of 0 to 28. In the initial validation study, it was estimated that a score above 7 is the one that best identifies patients who require treatment. It has been translated into Spanish and validated. It discriminates well between degrees of severity of nasal congestion and is suitable for detecting, measuring, and monitoring NO [36].
– DyNaChron. This self-completed questionnaire aims to evaluate the functional symptoms originating in the nose and paranasal sinuses, along with their physical and psychosocial consequences. It is specific for chronic nasal dysfunction. However, as NO is the most annoying and frequent symptom in nasal dysfunction, it should be mentioned in this section. It comprises 78 items organized into 6 areas and is designed primarily for use in a research environment. It has been validated, and the need for a shorter adaptation for use in clinical practice has been suggested [37].

Objective Evaluation

The ideal test to measure NO would be the one that would enable us to quantify—in an objective and reproducible way—the pathogenic mechanism by which this subjective sensation is triggered. At present, resistance, flow, volume, and nasal geometry are measured, although we are far from having an ideal test.

Before the test, the patient must be advised to avoid local or systemic drugs that might modify the nasal mucosa. The patient is placed at rest, sitting comfortably for 30 minutes, before the examination begins. The examination room should be kept at a constant temperature (18ºC-22ºC) and relative humidity (50%-60%) and remain free of ambient noise, which should be less than 60 dB to 50 dB during AcR [38-41].

RMN. This technique enables simultaneous measurement of pressure debit and variations of the airflow in the nasal passages during the breathing cycle. It may be anterior (when the measurement systems are placed at the level of the nasal nostril) or posterior (requires the placement of an intra-oral device to register choanal pressure). Both modalities can be active (the subject breathes actively or spontaneously) or passive (the subject is in apnea and a predetermined airflow is propelled through the

nostril) [38,40-42]. In its assessment of nasal patency, the International Standardisation Committee advises active anterior RMN (AARMN) using a face mask and a computerized record of pressure, flow, and resistance as the recommended test in daily clinical practice [39,41]. Active posterior RMN is advised specifically in septal perforation and occlusive septal deviations, given that a measurement for each nostril cannot be obtained separately. About 10% of measurements are false owing to movement of the tongue, salivation, or swallowing [41,42].

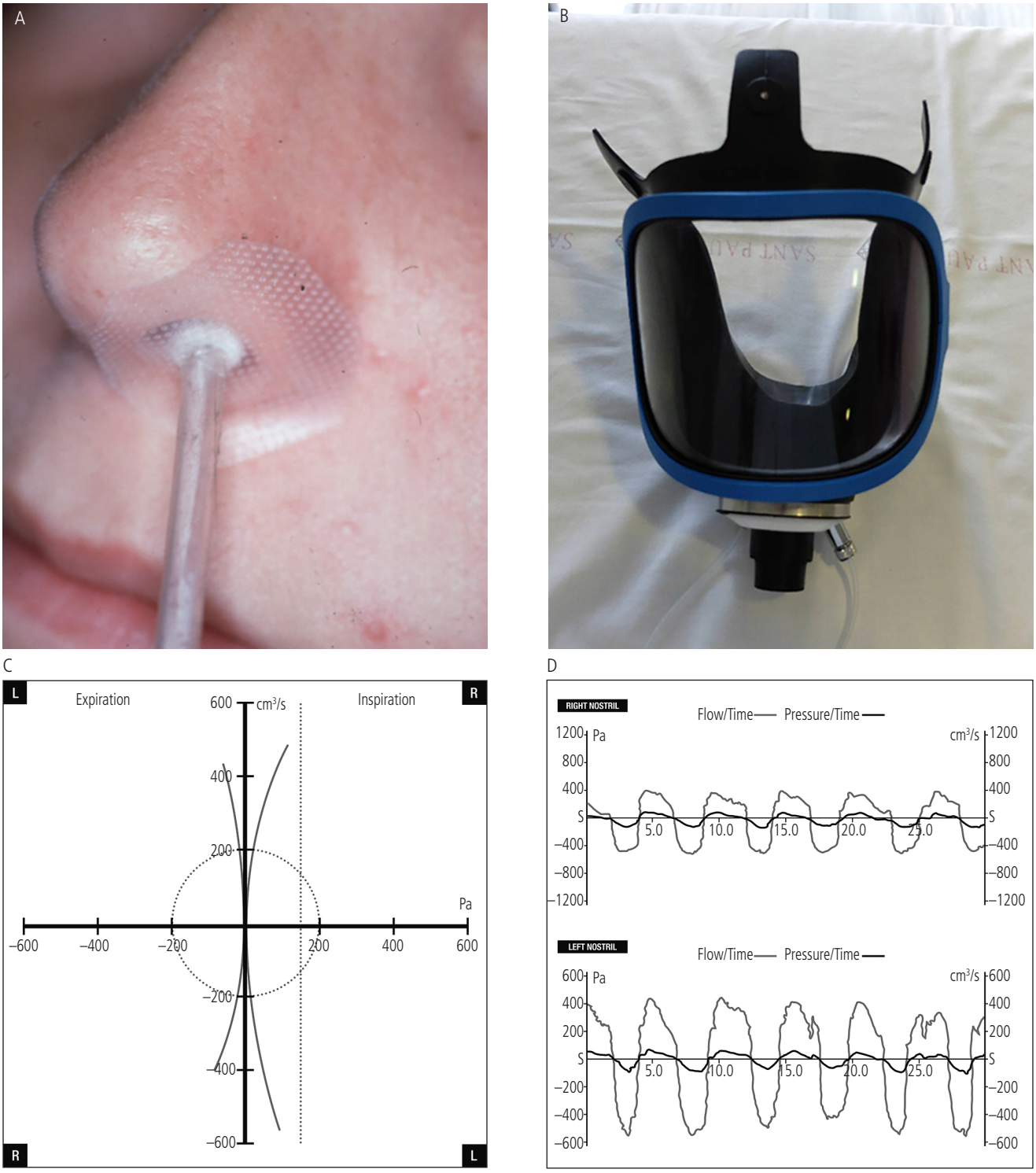


Figure 2. Active anterior rhinomanometry. A, Adhesive tape with cannula for measuring pressure. B, Face mask. C, XY recording axis (full consensus). D, Sinusoidal oscillograph (no general consensus). The flow and pressure values are recorded according to the time factor.

In AARMN, the noninvestigated side is sealed using adhesive tape to measure pressure changes without distorting the nasal vestibule, while the airflow is measured in the unoccluded fossa (Figure 2). The test is performed under baseline conditions and after vasoconstriction. The comparison with baseline results allows us to assess whether nasal respiratory failure is more likely to be functional than structural [38-40]. Finally, a third test can be performed after dilatation of the valve area, although the precise valve dilatation technique has never been properly agreed. In this test, significant changes in pressure and flow would be interpreted as the result of mechanical obstruction in the valve area [38].

The reference values obtained using AARMN have not been fully agreed. Some degree of variability is accepted according to the equipment used, age, weight, and the racial-ethnic characteristics of the population groups under study [41,43]. Table 3 shows the normal range of values in our geographical area for a population of leptorrhines, with no symptoms of NO or significant anatomical abnormalities [38]. In the same population, the normal values of unilateral nasal resistance at 100/150 Pa are <0.36/<0.45 Pa/cm^3/s, and the normal values of bilateral nasal resistance at 100/150 Pa are <0.18/ 0.22 Pa/cm^3/s, respectively [38].

Using AARMN, the nasal response can also be quantified after exposure to irritants or allergens [44]. If nasal resistance increases by 100% or more, the result is considered positive [42,44].

A new 4-phase calculation algorithm was recently proposed for AARMN and includes all phases of the nasal respiratory cycle, namely, acceleration and deceleration, both in inspiratory and expiratory phases. In addition to obtaining quantitative values, this is intended to introduce the measurement of parameters that would correlate better with the subjective sensation of nasal breathing [42,45].

AcR. This objective method for exploring the geometry of the nasal cavity enables us to analyze the acoustic reflection of a sound wave that travels along the nasal cavity and to measure areas and volumes at different points in the nasal fossa (Figure 3 A, B, and D) [46-48]. It is very difficult to define a normal nasal fossa. Countless variables must be taken into account in the context of mid-facial growth and development, as well as aspects linked to ethnic/racial characteristics, age, weight, and the tools used [48].

The procedure takes very little time and is performed at baseline and after vasoconstriction. Multiple sound stimuli are sent through the sonic tube while the patient is in apnea. Incorrect positioning and inclination of the sonic tube are the major source of errors (Figure 3C). AcR is much better than AARMN for the nasal provocation test, since it measures the volume and minimum transverse area (MTA) of the nasal passages quickly, directly, simply, and with high sensitivity and specificity [42,49,50].

The most important information in AcR is obtained in the first 5 cm and essentially in the first 3 cm of the nasal fossa. There are 2 notches or narrower areas on the graph (Figure 3D).

The first notch or I-notch is in the nasal vestibule. Since it has no anatomical correlation, it is strictly accepted as an AcR measure. The absence of nasal mucosa at this point means that it will not be modified by vasoconstrictors [51].

The second notch, or C-notch, is located 1.83 cm (on average) from the nostril, with an average section of 0.56 cm^2 in a nondecongested nasal cavity, and is anatomically correlated with the head of the inferior turbinate. The narrowest section (MTA) in healthy white individuals corresponds to the second notch (Figure 3D) and is the AcR measure of greatest clinical value; its average value in a normal nondecongested nostril is 0.56 cm^2 [46,48,51]. In whites, an MTA<0.4 at baseline correlates with NO [48]. Volume values can be obtained in the nasal passages at various distances from the nostril: the volume between 2 cm and 5 cm in the nasal cavity is the most sensitive measurement for showing changes in nasal permeability after decongestion of the nasal mucosa [52].

The result of the nasal provocation test is considered positive if the MTA and/or the nasal volume between 2 cm and 5 cm decreases by at least 25%-30% [44].

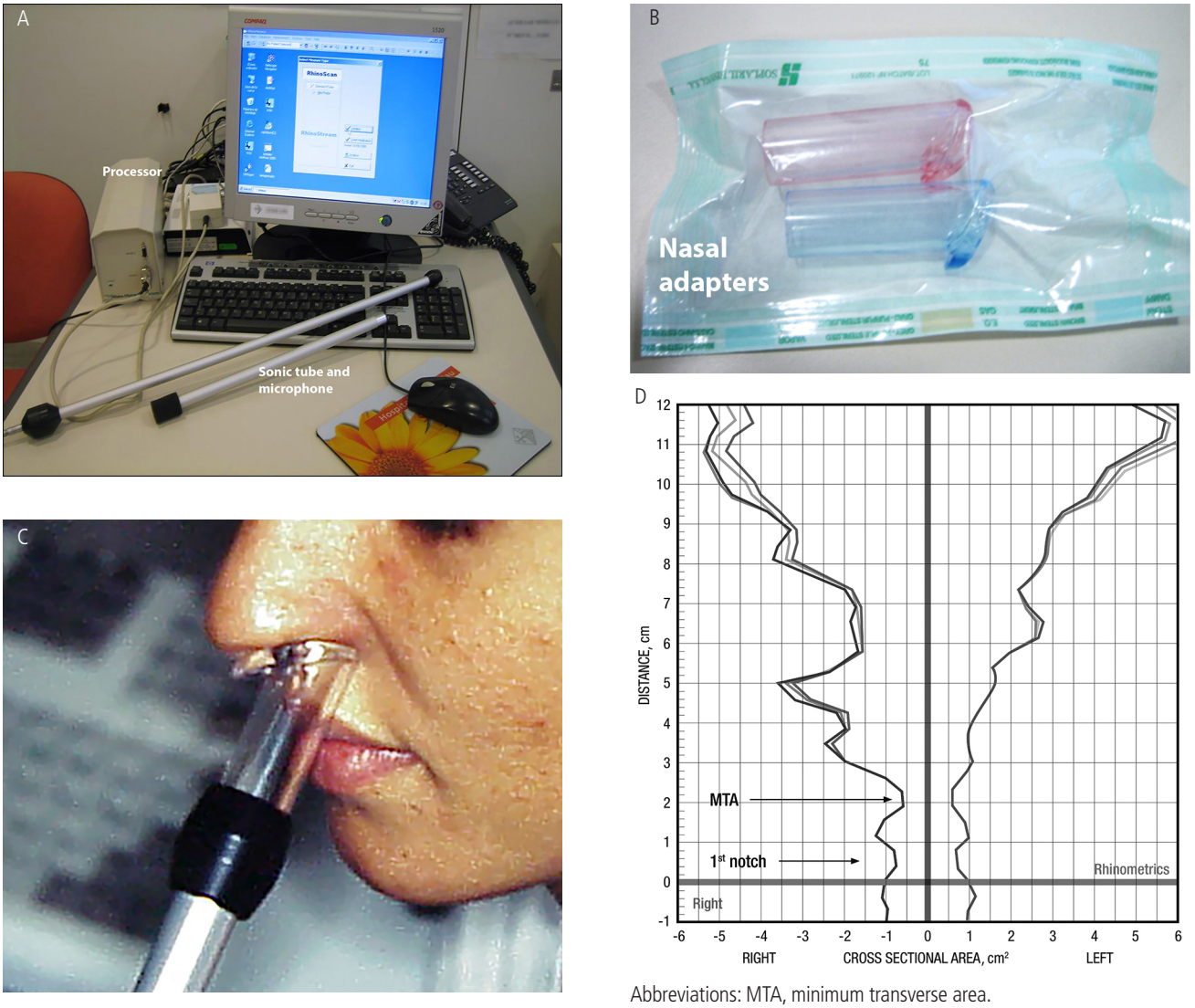
AARMN and AcR provide useful nasal permeability data based on the study of flow and of nasal geometry. These techniques are complementary [53].

PNIF. Like RMN, PNIF is a measurement of nasal permeability that provides nasal flow data expressed in liters per minute. It can be obtained by means of an inspiratory maneuver (PNIF) or forced expiration (PNEF) [54]. Both techniques correlate and are useful in measuring nasal flow [55]. As PNIF seems to correlate better with nasal resistance and given the possible contamination of the PNEF meter by secretions, the use of PNIF is more generalized [56].

Table 3. Grading of the Severity of Nasal Obstruction Based on Strictly Rhinomanometric Criteria

AARMN GROUPS	Total Flow, mL/s (Male)	Total Flow, mL/s (Female)	Unilateral Flow, mL/s (Male)	Unilateral Flow, mL/s (Female)
Normal	>700	>630	>350	>315
Mild NO	600-699	530-629	300-349	265-314
Moderate NO	500-599	430-529	250-299	215-264
Severe NO	300-499	230-429	150-249	115-214
Very severe NO	<299	<229	<149	<114

Abbreviations: AARMN, anterior active rhinomanometry; NO, nasal obstruction.



Abbreviations: MTA, minimum transverse area.

Figure 3. Acoustic rhinometry. A, Basic elements. Microphone located in the sonic tube. B, Nasal adapters. C, An intermediate piece or adapter is applied in the nasal window, which in turn is connected to the sonic tube. The adapter has a constant and pre-set length and section. D, The results obtained are recorded on a graph, where the areas are highlighted according to the distance from the nasal window. An integral provides information on volume. Two notches can be seen in the nondecongested nasal fossa. The narrowest area of the nasal cavity is usually located less than 3 cm from the nasal window.

PNIF is a simple and rapid technique that is carried out using a portable device. Measurement and interpretation do not require sophisticated equipment. The portable device is a plastic tube (20 cm long, 3-4 cm in diameter, and calibrated at 30-370 L/min) to which a face mask is attached (Figure 4). From an expiratory maneuver to residual volume, a forced inspiration is made while the lips are sealed. Three measurements that must not vary by more than 10% are taken, and the best one is chosen [57]. The nasal cavity and the device must be clean, the mask must be correctly fitted without being deformed, and the maneuver must be carried out with the proper effort. Its usefulness in clinical practice lies in the fact that it is the only method available for home monitoring.

Measurements cannot be taken if nasal collapse occurs or when there are very serious obstructions [54]. A wide range of values of normality have been published in adults [31,44,58–61] and children [58-61]. In general, values are higher in men than in women and are proportional to height; they increase from childhood to adulthood and then decrease in the elderly [57,62].

Cut-off values of 115-120 L/min have been suggested to distinguish normality from obstruction [31,57,63,64], although there are no absolute values of normality and the patient is the best judge for evaluating changes.

The measurement of unilateral PNIF may be useful in the preoperative assessment of unilateral obstruction, such as septal deformity [65].

PNIF is closely related to maximum expiratory flow [58,63,66,67], since a low quotient could correspond to an increase in bronchial resistance rather than a decrease in the PNIF. Its relationship with the symptom score measured using a VAS is controversial [31,63,68,69], although it seems

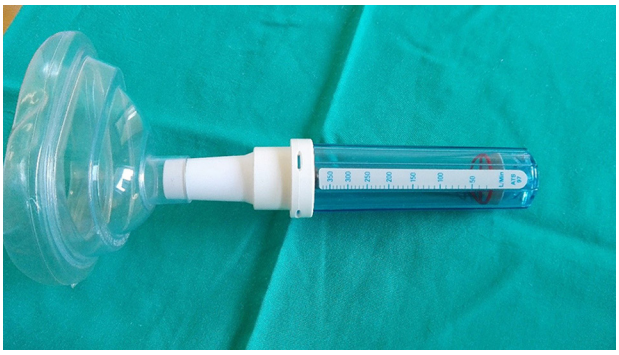


Figure 4. Portable device for measuring peak nasal inspiratory flow (PNIF).

to improve when compared with validated questionnaires such as the Sino-Nasal Outcome Test (SNOT-22) and NOSE [65,68,70-73].

Some studies consider it as sensitive as AcR in both allergen-specific and nonspecific nasal provocation tests [31,74]. Its ability to discriminate healthy individuals from patients is similar to that of AARMN [31,75].

In nasal provocation, a ≥40% reduction in PNIF is considered positive [44,76,77].

Other Techniques

Data on nasal spirometry are scarce [78]. Other permeability assessment techniques, such as computational analysis of nasal fluid dynamics from simulations on computed tomography, are expensive and still not widely used [79,80].

Correlation Between Subjective and Objective Methods in Evaluating NO

How Subjective Methods Are Correlated

Yepes-Nuñez et al [31] evaluated NO subjectively in 184 volunteers using VAS and a symptom scale. The correlation found between these subjective methods was moderate (r=0.68). In another study that evaluated NO both objectively and subjectively in 2 groups of patients (some treated with surgery and others treated with topical corticosteroids), a strong correlation (r=0.8) was detected between the 2 subjective tests used, namely, NOSE and VAS [81].

Despite these studies not being designed for purpose, the data lead us to affirm that there is a moderate to strong correlation between subjective methods for evaluating NO.

How Objective Methods Are Correlated

In most studies, the objective methods used are AARMN, AcR, and PNIF.

A study conducted in 65 patients with NP revealed a significant but weak inverse correlation (r=–0.29) between PNIF and polyp size based on endoscopic findings [82]. Another study evaluated the correlation between different variables of the AARMN and the AcR [31]. A moderate correlation was detected between the MTA value and resistance, although correlations between the other variables were weak. PNIF was moderately correlated with AcR (r=0.45) and weakly correlated with AARMN (r=0.25).

These results reinforce the idea that the various objective methods measure specific aspects of NO and are therefore not comparable but complementary.

How Subjective Methods and Objective Methods Are Correlated

Several publications aim to correlate objective and subjective methods; however, the fact that these methods are not standardized means that there are differences in the study designs. The results of the studies considered most relevant are summarized below.

Lamb et al [83] used AcR, PNIF, NOSE, and VAS to evaluate NO in patients who came to the clinic for another reason (suspicion of obstructive sleep apnea syndrome). No significant correlation was detected between the objective and subjective measures used.

A moderate correlation was detected between the endoscopic size of the polyps and the evaluation of NO by VAS [82] in patients with NP.

Mendes et al [84] used AARMN, AcR, and a symptom scale in children with AR and healthy controls both globally and in each nostril separately. No significant correlation was detected between the objective and subjective methods used.

Weak correlations have been reported (r<0.4) between the methods used (AARMN, AcR, PNIF, VAS) [31].

Menger et al [72] evaluated the usefulness of MTA using computed tomography (CT) when comparing it with AARMN, AcR, and PNIF, as well as with the NOSE questionnaire in patients who were to undergo valve surgery because of alar collapse during inspiration. Significant correlations were detected between MTA-CT and NOSE and between PNIF and NOSE. No correlation was found between the subjective method used (NOSE) and AARMN or AcR [72].

A study that evaluated NO in children using nasal endoscopy, AcR, and VAS did not detect any significant correlation between the techniques, while a weak correlation was found between endoscopic findings (unilateral, bilateral, or absent obstruction) and VAS [34].

A very weak correlation (r=0.07) has been reported between AARMN and the NOSE questionnaire, and also with VAS (r=0.09) [81].

Finally, Mozzanica et al [85] evaluated nasal permeability using NOSE, VAS, and AARMN in patients treated for NO and demonstrated weak to moderate correlations between the objective and subjective methods, with the highest correlation (r=0.54) detected between unilateral resistance and the second item of the NOSE.

In view of these results, we conclude that according to the studies reviewed, no correlation can be established between the objective and subjective methods used for evaluating NO. As any correlation observed is weak, we must consider these methods complementary and not exclusive.

Quality of Life and NO

The effect of NO on the nasal passage reduces QOL both in patients with AR [86,87] and in patients with CRS with/

without NP [88-91] and leads to structural alterations of the nasal cavity [92,93]. Deterioration of QOL affects all age groups [94].

The impact of AR on QOL is well documented [95]. Some studies show a good correlation between the degree of NO determined using a validated questionnaire (CQ7) and specific QOL parameters in patients with AR [36]. However, other studies conducted in the primary care setting find little correlation between the intensity of NO measured by the symptoms scale and specific QOL questionnaires in AR (assessed using the Rhinoconjunctivitis Quality of Life Questionnaire [RQLQ]) [87].

AR exerts a negative influence on the quality of sleep, which undoubtedly has an impact on QOL, daily activities, and learning [96]. NO is one of the most annoying symptoms of rhinitis and is a key factor affecting sleep quality [97]. A large-scale Spanish study found that 53% of patients with AR slept badly and 21% experienced excessive daytime sleepiness, with obstruction, rhinorrhea, and pruritus being the factors that best correlated with these observations [98]. Moreover, if NO is specifically measured with validated instruments (NOSE questionnaire, CT scan, and nasal endoscopy) in patients with CRS, the correlation between NO and sleep quality is also significant, although weak [99].

On the other hand, effective treatment of NO can reduce the daytime sleepiness resulting from sleep disturbances in AR [100]. Similar effects can be observed in CRS [101-103].

The QOL questionnaires most used in AR (Table 4 [35,36,86,104-112]) are the RQLQ (validated in Spanish [109]) and the ESPRINT (Spanish QOL questionnaire for rhinitis), which was developed and validated in Spanish for the Spanish population [113] and has reference values based on the severity of AR [114]. It is the instrument of choice for the Spanish-speaking population [86]. Both correlate well with symptom counts, but only the RQLQ has shown a significant correlation with NO [109].

As for CRS (Table 4), SNOT-22 stands out because of its usefulness, although the Rhinosinusitis Disability Index, the Questionnaire of Olfactory Disorders, and the Sinusitis Control Test [88] have also been validated. The symptoms that most contribute to the deterioration of QOL appear to be otic or facial pain and sleep disturbance [101]. On the other hand, nasal symptoms do not seem to correlate well with the cognitive impairment observed for CRS [115]. The EuroQOL-5 Dimensions (EQ-5D) is the most commonly used generic questionnaire [88]. Other questionnaires not specifically designed to assess obstruction, such as NOSE [35] and CQ7 [36], also address QOL-related issues.

An important aspect of QOL is the calculation of "utility values" extracted from the EQ-5D questionnaire and used to calculate quality-adjusted life years, which is a numerical value that ranges between 0 and 1 (1 corresponds to the best possible state of health) and in allergic respiratory diseases varies between 0.60 and 0.85 [116]. In this sense, respiratory diseases resemble other chronic diseases such as diabetes, kidney failure, and chronic liver disease [116].

The high costs of AR are well known [95,116], with indirect costs being higher and doubling or tripling direct costs.

Table 4. Questionnaires and Scales Commonly Used in Allergic Rhinitis and Chronic Rhinosinusitis (Modified From Rudmik et al [88] and Meltzer et al [95])

Acronym	Range	Score Range	Spanish Validation	Observations
CQ7 [36]	7	0-28	Yes	Specific questionnaire for measuring nasal obstruction
NOSE [35]	5	0-100	Yes	Specific questionnaire for assessing symptoms in patients with nasal obstruction
EQ-5D [104]	15	0-100	Yes	QOL generic questionnaire that allows calculation of QALY
SF-36 and SF-12 [105]	36/12	0-100	Yes	QOL generic questionnaires for comparison with other conditions
RSDI [106]	30	0-120	Yes	Used occasionally to evaluate QOL in nasal polyposis
RSOM-31 [107]	31	0-155	Yes	Used occasionally to evaluate QOL in nasal polyposis
SNOT-22 [108]	22	0-110	Yes	The most widely disseminated questionnaire for QOL in CRS
RQLQ, Mini-RQLQ [109]	28/12	0-168/72	Yes	The most widely used international questionnaire for QOL in allergic rhinitis
ESPRINT-15 [86]	15	0-60	Yes	Specifically developed in Spanish and validated in the Spanish population. Recommended by the authors to evaluate QOL in allergic rhinitis in Spanish-speaking populations.
RhinAsthma [110]	42	0-100	No	Joint evaluation of QOL in rhinitis and asthma
QOD [111]	25	0-57	No	Specific questionnaire that evaluates the sense of smell
PSQI [112]	19	0-21	Yes	Used to evaluate sleep quality

Abbreviations: CQ7, Congestion Quantifier Seven-Item test; CRS, chronic rhinosinusitis; EQ-5D, EuroQol Group. EuroQol; ESPRINT-15, ESPRINT-15 Questionnaire; NOSE, Nasal Obstruction Symptom Evaluation; PSQI, Pittsburgh Sleep Quality Index; QALY, quality-adjusted life year; QOD, Questionnaire of Olfactory Disorders; QOL, Quality of Life; RhinAsthma, Specific QOL questionnaire for patients with rhinitis and asthma; RQLQ, Rhinoconjunctivitis Quality of Life Questionnaire; RSDI, Rhinosinusitis Disability Index; RSOM-31, 31-Item Rhinosinusitis Outcome Measurement; SNOT-22, Sinonasal Outcome Test.

Presenteeism (loss of productivity while in the workplace) is very high in AR patients, surpassing that of other chronic diseases such as diabetes [117]. According to a study carried out in Spain [118], the total cost of AR per patient per year (treatment by a specialist) reaches €2327 (direct, €554; indirect, €1773). However, no specific data are available on the direct influence of the degree of NO on the amount of these costs, although significant differences have been established depending on severity, especially with regard to indirect costs [118].

Therefore, we can conclude that both AR and CRS imply appreciable impairment of QOL and sleep quality. These conditions also generate high costs, which are related to severity and persistence, and the intensity of the symptoms, including NO, plays an important role.

Medical Treatment (Table 5)

In this case, the search methodology was based on providing the maximum scientific evidence while including systematic reviews and meta-analyses (level of evidence, Ia).

Nasal decongestants

Both oral decongestants (ephedrine, phenylephrine, phenylpropanolamine, and pseudoephedrine) and intranasal decongestants (phenylephrine, naphazoline, oxymetazoline, tramazoline, xylometazoline) have proven to be effective in treating NO associated with AR and CRS with NP (Table 5). They reduce sinusoid blood-flow, improve permeability, and decrease resistance to passage of air. However, the adverse effects of prolonged use of these drugs not only produce drug-induced rhinitis and organic nasal lesions, but may also be responsible for serious systemic alterations [119–124]. Therefore, their use, dose, frequency, and duration should be restricted.

Table 5. Grading of the Severity of Nasal Obstruction Based on Strictly Rhinomanometric Criteria

	Allergic Rhinitis[a]	CRS With NP[a]
Antihistamine H_1		
Intranasal	+	0
Oral	+	0
Corticosteroid		
Intranasal	+++	+++
Oral	++++	++++
MP-AzeFlu	++++	NS
Chromones	+	+
Nasal decongestants		
Intranasal	+++++	+
Oral	+++	++
Antileukotriene	++	+
Allergen immunotherapy	+	0
Biologics	++	++++
Nasal saline solution	+	++

[a]Decongestive efficacy: very high (+++++), high (++++), quite high (+++), moderate (++), little (+), null (0), no studies (NS).
Abbreviations: MP-AzeFlu: intranasal formulation of azelastine hydrochloride (anti-H_1) and fluticasone propionate (corticosteroid) nasal spray.

Rhinitis. One systematic review showed that a single intranasal dose significantly improved acute nasal congestion and reduced nasal airway resistance in adults with common cold [125]. A meta-analysis also demonstrated this effect with oral administration of phenylephrine [126].

Rhinosinusitis. Several systematic reviews have not provided sufficient scientific evidence to justify recommending the use of nasal decongestants in acute rhinosinusitis (ARS) or CRS [127].

Corticosteroids

Intranasal corticosteroids (INCs) (beclomethasone, budesonide, ciclesonide, fluticasone propionate, fluticasone furoate, mometasone, triamcinolone) have a potent anti-inflammatory effect and have proven to be effective in treating NO in both rhinitis and rhinosinusitis, as shown in several international consensus statements [127-131]. Corticosteroids decrease inflammatory infiltrate and vascular permeability [132].

Rhinitis. One systematic review highlights the lack of evidence to support their use in NO caused by the common cold [133]. However, INCs are the most effective medication for treating AR [129,134] and have proven to be more effective than other medications. They are also the first-line drugs for treating NAR [135].

Oral corticosteroids (OCs) (prednisone, methylprednisolone, deflazacort) have an even more potent effect on NO, with predominance over the nonvascular component, both in AR and in moderate-severe NAR compared with placebo. Given the risk of adverse effects caused by prolonged use, OCs are not indicated as primary treatment, but for controlling exacerbations when the usual medical treatment fails.

Rhinosinusitis. International consensus statements [127,130] recommend the use of INCs for both ARS and CRS with NP or CRS without NP. They improve NO, as well as edema, polyp size [136,137], and recurrence after surgery [138]. In CRS with NP, administration in droplets has proven to be more efficacious than spray [128]. There is no clear recommendation on prophylaxis of recurrent ARS.

OCs are effective in improving NO and reducing the size of nasal polyps [139,140], although they should be reserved for the short-term treatment of the most severe, uncontrolled cases [141].

H_1 Antihistamines

Second-generation H_1 antihistamines (anti-H_1)—both oral agents (bilastine, cetirizine, desloratadine, ebastine, fexofenadine, levocetirizine, loratadine, mequitazine, mizolastine, rupatadine) and intranasal agents (azelastine, levocabastine, olopatadine)—exert their antiallergic effects as inverse agonists of the H_1 receptor.

Rhinitis. Both oral and intranasal anti-H_1 have shown efficacy in NO in patients with AR [142,143], although the magnitude of the benefit is modest compared with decongestants and INCs [144].

Rhinosinusitis. Some improvement in NO has been described in patients with NAR or rhinosinusitis, but the evidence is very weak, with the result that anti-H_1 are not recommended except in cases of concomitant AR [130]. Similarly, there is no evidence of efficacy in the common cold [145].

Intranasal formulation of fluticasone + azelastine (MP-AzeFlu)

Initial studies suggest that the action that explains the superior clinical effect of MP-AzeFlu is based on a greater reduction in proinflammatory mediators [146] combined with greater stimulation of anti-inflammatory genes [147].

Rhinitis. The efficacy of MP-AzeFlu has been shown to be superior to INCs and intranasal anti-H_1 monotherapy in patients with moderate-severe, poorly controlled AR or NAR [148-150].

Rhinosinusitis. Except for models of eosinophilic inflammation in vitro [146,147], no studies have been performed.

Antileukotrienes

Leukotrienes are inflammatory mediators present in AR and CRS with NP and are partly responsible for chronic NO. Therefore, antileukotriene drugs (montelukast, zafirlukast) may improve NO.

Rhinitis. The effect on NO in monotherapy is weaker than that obtained with INCs; therefore, it is not advised [151,152]. Antileukotrienes have been shown to be more effective than anti-H_1 against the nocturnal symptoms of AR (including NO) but not against diurnal symptoms [153]. Combination with anti-H_1 is not recommended, given that few efficacy tests have been conducted on these drugs in monotherapy.

Rhinosinusitis. There is insufficient evidence to recommend the use of antileukotrienes for treating NO in CRS with NP [154]. In patients with aspirin-exacerbated respiratory disease (AERD) or patients taking nonsteroidal anti-inflammatory drugs, their benefit may be limited [127].

Intranasal chromones

Intranasal chromones (cromoglycate, nedocromil) act on sinonasal inflammation mainly by stabilizing mast cells. Their effect on NO in AR is marginal and inferior to that of INCs [129]. Efficacy has not been demonstrated in patients with CRS and NP [130].

Anticholinergics

Activation of the parasympathetic system causes vasodilation and hypersecretion of the nasal mucosa, which is responsible in part for NO and may potentially improve with intranasal anticholinergics (ipratropium bromide). However, one systematic review has shown some effect on controlling rhinorrhea but none on NO in the common cold or on AR and NAR [155].

Other medications

Capsaicin (the spicy component of pepper) is a neurotoxin that stimulates the nerve endings so that they release substance P and other neuropeptides involved in the neurogenic inflammation present in rhinitis and rhinosinusitis. Although it is considered a therapeutic option in NAR, there is no evidence for its use in NO caused by AR and CRS [156,157].

Lysine acetylsalicylate has been used topically in soluble form to desensitize aspirin in patients with AERD. In progressive doses and administered together with INCs, there is a certain clinical benefit in which NO is improved and the size of the NP is reduced [158].

In several controlled studies in children and adults with rhinitis or rhinosinusitis, nasal washes or showers with saline solution (isotonic or hypertonic), have proven to improve NO [159,160]. A recent meta-analysis supports its use in the treatment of CRS with NP [161] both before and after surgery. It is recommended in volumes greater than 200 mL and can be used concomitantly with INCs [127,130].

There is no scientific evidence of the efficacy of other treatment options, such as menthol, mucolytics, furosemide, and proton pump inhibitors, with the result that they are not recommended [162]. Intranasal *Cyclamen europaeum* has shown some efficacy against NO in ARS [163].

Avoidance of allergens and irritants

Environmental control measures aim to reduce or eliminate allergens and irritants to obtain clinical benefits in patients with AR and/or rhinosinusitis, especially in those whose exposure correlates with the onset of naso-ocular symptoms [134]. However, the available data tend to be global and do not specifically address improvement in NO. In pet allergies, the most effective measure is to remove the animal from the patient's environment. Although individualized actions aimed at reducing exposure show no reduction in AR symptoms, combined and maintained measures do not ensure a clear clinical benefit either [164]. In AR caused by mites, interventions to reduce allergenic exposure may improve AR symptoms [165], although combined actions (antimite mattress covers, acaricide, high-efficiency particulate air filters) and continuous actions are also necessary.

Immunotherapy

AR. Allergen-specific immunotherapy (AIT) should be offered to AR patients who do not respond sufficiently well to pharmacological treatment, with or without environmental control measures [134,166]. AIT modifies the natural history of the disease, improves naso-ocular symptoms (NO included), and reduces the need for medical treatment. In the long term, it can improve or prevent asthma and conjunctivitis, improve QOL, and prevent the development of new sensitizations to aeroallergens [134,167]. Both subcutaneous immunotherapy (SCIT) [168] and sublingual immunotherapy (SLIT) [169,170] have proven effective in reducing the symptoms (including NO) of seasonal and perennial AR [171].

Total symptom score is the main variable in systematic reviews and meta-analyses, both in SCIT [172] and in SLIT

in drops [173] or in tablets [174]; therefore, specific data on NO are not usually published [171]. In a review of clinical trials conducted using grass pollen tablets in a pre/coseasonal pattern, a reduction was observed compared with placebo in children (31%) and adults (43%) with AR [175]. Moreover, in a clinical trial performed with mite tablets in mild or moderate AR, NO improved significantly compared with placebo [176].

Local allergic rhinitis. A clinical trial with mite SLIT demonstrated relief of nasal symptoms in addition to a negative nasal provocation result in 50% of patients with local allergic rhinitis [177].

CRS. A recent systematic review assessed the clinical efficacy of AIT in patients with CRS with and without NP and in patients with allergic fungal rhinosinusitis. The conclusions were very limited owing to the scarcity of available data. In addition, efficacy tests do not support its use in CRS [178].

Biological therapy

These are humanized or human monoclonal antibodies that are mostly administered subcutaneously and aimed at blocking specific sinonasal inflammatory targets.

Rhinitis. Omalizumab (free anti-IgE) has demonstrated its efficacy in AR [179], although it is not authorized for this disease.

Rhinosinusitis. A series of monoclonal antibodies have been administered against different targets in phase 2 or 3 studies for the treatment of moderate-severe CRS with NP that are resistant to treatment with INCs. These include omalizumab [180], dupilumab (anti-IL-4Rα [181]), mepolizumab (free anti-IL-5 [182]), reslizumab (free anti-IL-5 [183]), benralizumab (anti-IL-5Rα [184]), and AK-001-002 (anti-siglec8 [185]). These biological treatments have a potentially major effect on NO and the size of NP.

Surgical treatment

Managing NO requires a correct diagnosis, medical treatment, and, in some cases, surgical treatment when medical treatment fails to improve the condition or in those cases where another therapeutic approach is impossible. Scientific evidence in favor of surgery is generally less robust than for pharmacological approaches (owing to the difficulty in reducing variability in the technique or evaluating outcome with double control groups). The methodology of studies on surgical innovations must be improved [186,187].

Surgical treatment depends on etiology. Consequently, it is often necessary to combine several techniques in the same patient, and subsequent medical treatment may be necessary.

In certain cases of rhinitis with turbinate hypertrophy, surgical treatment has been shown to improve nasal permeability when pharmacological treatment maintained for at least 3 months has failed [134,188-190]. Numerous turbinoplasty procedures have been described [191,192]. For many years, intramucosal volume has been reduced using techniques such as radiofrequency [193-198], ultrasound [199], cryosurgery [198] and laser vaporization [200,201]. These techniques are well tolerated, can be performed without general anesthesia, have few complications, and are widely used, although their effectiveness tends to decrease over time [202]. In procedures that act by excising mucosa and turbinate bone (partial turbinectomy, submucosal resection [203]), the risk of complication seems somewhat higher [191,204,205], although the results may be better [193,205-209]. Fracture/dislocation of the inferior turbinate [210,211] is used in combination with other techniques for cases where the turbinate is increased by the bone component.

In CRS with NP, endoscopic surgical treatment has been shown to be beneficial in patients with severe symptoms who do not respond to appropriate medical treatment [20,127,128,212-218] and may be more cost-effective [219,220]. The delay in surgery can negatively influence postoperative results and healthcare costs [221], although more studies are necessary to confirm this observation [218]. A short course of systemic corticosteroids improves surgery [222]. While radical surgery seems to obtain better results [223], the extent of the intervention remains unclear [224]. In recurrences, more aggressive surgery may be indicated [225]. Treatment with INCs should continue after surgery [226], and very long-term control leads to improvement [227]. Surgery may be beneficial in patients with NP with associated asthma [228,229], AERD [230], or cystic fibrosis [231-233]. Surgery is also indicated in CRS without NP that does not improve with medical treatment [20,234].

The collapse of the nasal valve, which leads to closure of the airway during inspiration, is a frequent and less well-known cause of NO [235,236]. Sometimes it occurs after rhinoplasty and septal or turbinate surgery [237]. The numerous techniques proposed to remedy this situation include grafting [238-243] (eg, spreader and batten grafts [244–248]), implants [249,250], and other procedures [251-256].

The mechanical or anatomical causes of NO can only be addressed with surgery. The endoscopic approach is replacing other approaches [257-259] in choanal atresia. Surgery is mandatory when choanal atresia is bilateral; treatment can be delayed in unilateral atresia. In septoplasty, surgical techniques vary depending on the complexity of the anatomical alteration in the nasal septum [260,261]. Septal perforations are also a cause of NO due to airflow alteration. Surgical techniques depend on the size and location of the obstruction [223,262-269].

In benign tumors such as inverted papilloma or juvenile angiofibroma, endoscopic treatment is usually the approach of choice and aims to achieve complete surgical resection [270]. In the case of malignant tumors, therapy should be designed on an individual basis, and decisions should be taken by an interdisciplinary tumor committee [270,271].

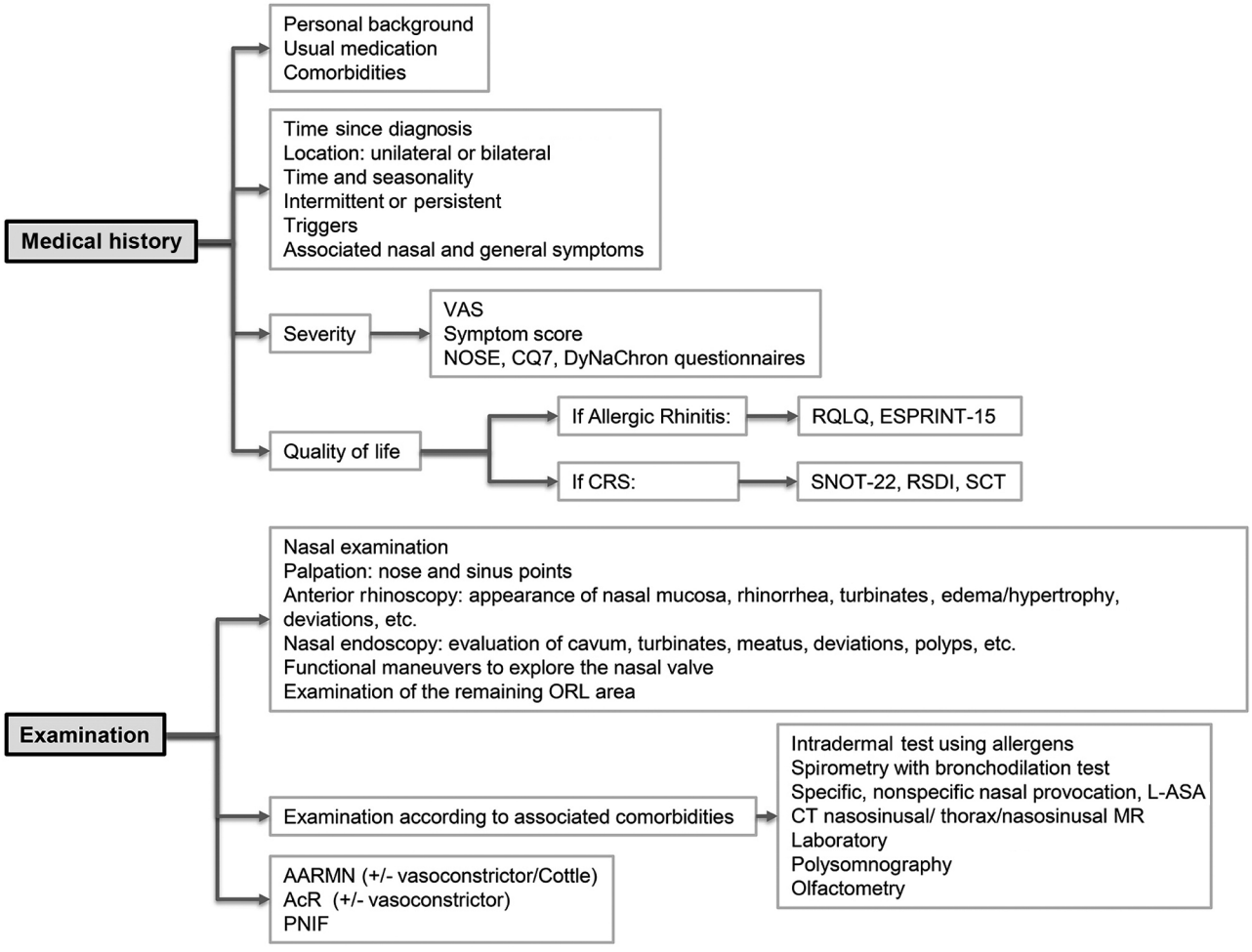
Management of Patients With NO

NO is frequently reported by patients in primary care and in specialized care. It has a huge impact on patients' QOL and especially on sleep quality. As it can be caused by various factors, a complete medical history and clinical examination are the main basis of its etiological diagnosis. Furthermore, although both the pattern and location can suggest the underlying disease, objective and subjective assessment tools are useful for evaluation of NO. As these techniques measure different aspects, they are complementary. Figures 5 and 6 summarize how to assess patients with NO.

Finally, treatment must address the cause. Current therapeutic options include many topical and systemic drugs, although surgery is necessary in some cases.

Key Points

- NO is one of the most common reasons for consultation in primary and specialized care.
- NO can be caused by drugs and by anatomical, inflammatory, neurological, hormonal, functional, and environmental factors.
- Unilateral NO that progresses over time may be a sign that the disorder has its origin in a tumor.
- NO can be subjectively evaluated using a VAS, a symptom rating scale (eg, Likert-type), and/or a questionnaire to assess the effect of NO (NOSE, CQ7, or DyNaChron).
- NO can be objectively evaluated using techniques that assess nasal geometry (AcR) or nasal permeability (AARMN and PNIF).
- The objective techniques for evaluation of NO measure different aspects and are therefore not comparable but complementary.
- The objective and subjective methods for evaluation of NO do not correlate or do so very poorly; therefore, they should be considered complementary and not exclusive.
- NO affects the patient's QOL, especially sleep quality.
- NO should be treated according to its cause.
- Nasal decongestants have proven to be effective in treating NO associated with AR and NAR, but there is no evidence that this is the case in ARS or CRS. Given their adverse effects, use should be limited both in dosage and in time.



Abbreviations: AARMN, anterior active rhinomanometry; AcR, acoustic rhinometry; CQ7, Congestion Quantifier Seven-Item test; CRS, Chronic Rhinosinusitis; CT, computed tomography; ESPRINT-15, ESPRINT-15 Questionnaire; L-ASA, lysine acetylsalicylate; MR, magnetic resonance; NOSE, Nasal Obstruction Symptom Evaluation; ORL, otorhinolaryngologic; PNIF, peak nasal inspiratory flow; RQLQ, Rhinoconjunctivitis Quality of Life Questionnaire; RSDI, Rhinosinusitis Disability Index; SCT, Sinusitis Control Test; SNOT-22, Sinonasal Outcome Test; VAS, visual analog scale.

Figure 5. Algorithm for evaluating nasal obstruction.

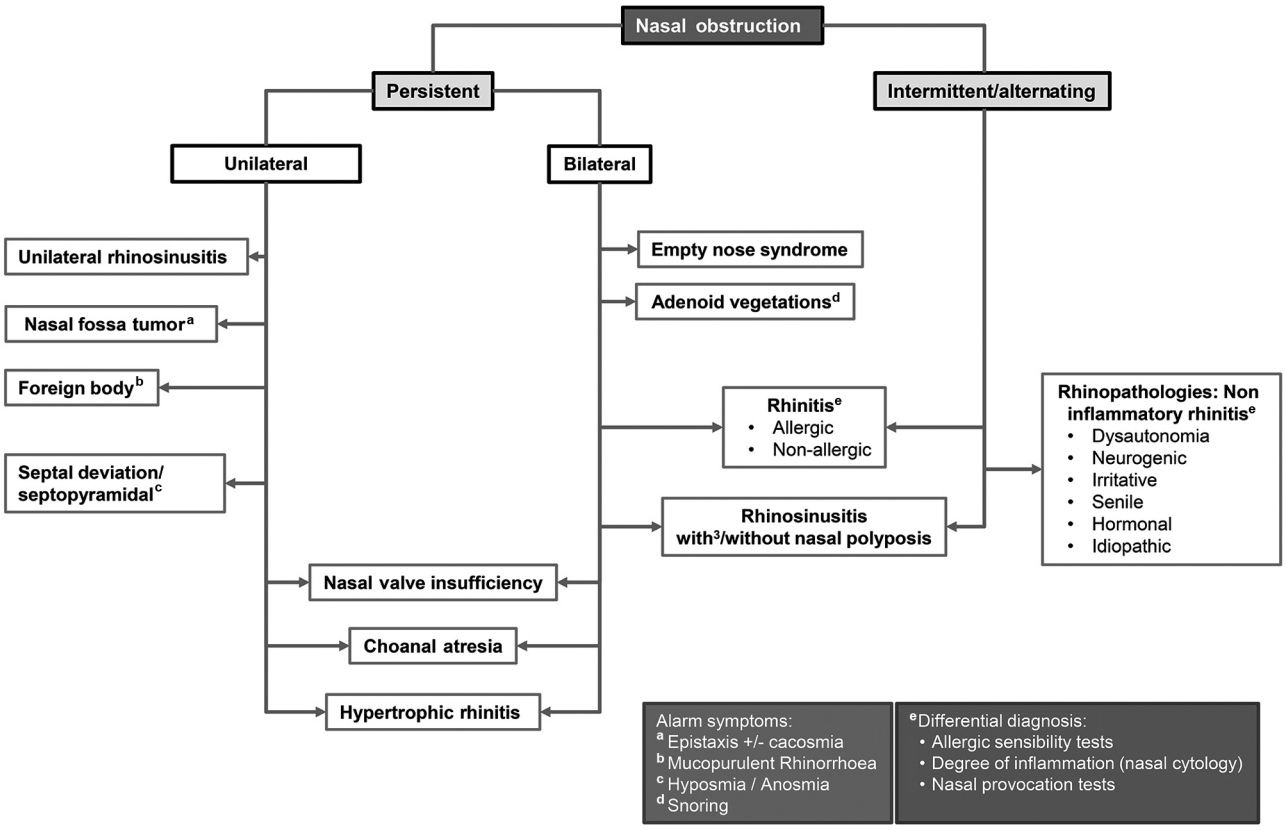


Figure 6. Algorithm for differential diagnosis of nasal obstruction.

- INCs have proven to be efficacious against NO in rhinitis and rhinosinusitis. Oral corticosteroids have a more potent effect, but they should not be indicated as first-line treatment, except for the control of exacerbations when routine medical treatment fails.
- Both oral and intranasal anti-H_1 have proven effective against NO in patients with AR, although the benefit is modest compared with decongestants and INCs.
- The efficacy of the intranasal formulation MP-AzeFlu is superior to that of INCs and intranasal anti-H_1 monotherapy in patients with moderate-severe, poorly controlled AR or NAR.
- Nasal washes or showers with saline solution (isotonic or hypertonic) improve NO in rhinitis and rhinosinusitis.
- Although AIT has an "A" recommendation for AR, there are no specific data for its effect on NO.
- Biological drugs may play a key role in improving NO associated with CRS and NP, although they are still in the clinical trial phase for this indication. There are also studies of efficacy in AR.
- Surgery may be necessary after medical treatment has failed, or when other therapeutic approaches are not possible. It will often be necessary to combine several techniques in the same patient or to combine these techniques with medical treatment before or after surgery.

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Conflicts of Interest

Antonio Valero Santiago has participated in advisory boards and acted as a consultant for FAES Farma, Orion Pharma, Novartis, Uriach Pharma, Mylan Pharmaceuticals, and Stallergenes. He has received speaker's honoraria from Novartis, GSK, Stallergenes, Chiesi, Leti, Boehringer Ingelheim, Menarini, and Thermo Fisher and grant support from Novartis, FAES Farma, and Uriach Pharma.

Miguel Armengot Carceller is or has been a member of scientific advisory committees for ALK-Abelló and has received speaker's honoraria from MSD.

Ana María Navarro Pulido has participated in advisory boards and acted as a consultant for ALK-Abelló, Ferrer, GSK,

MEDA, and Stallergenes. She has received speaker's honoraria from Allergy Therapeutics, Astra-Zeneca, FAES, GSK, Leti, Menarini, Merck, MSD, and Uriach.

Teresa Dordal Culla has received speaker's honoraria from ALK-Abelló and FAES Farma.

Carlos Colás Sanz has received funding for research projects and/or honoraria as a speaker for GSK, Menarini, MYLAN-MEDA, and Novartis.

Alfonso del Cuvillo Bernal has received funding for research projects, participated in advisory boards, acted as a consultant, and/or received honoraria as a consultant or speaker for ALK-Abelló, FAES, GSK, LETI, MSD, Menarini, MYLAN-MEDA, Novartis, UCB Pharma, and Uriach Group.

Joaquim Mullol i Miret is or has been a member of national and international scientific advisory committees (consultancy) and has received conference fees and fellowships for research projects from ALK-Abelló, FAES, Genentech, GSK, Menarini, MSD, MYLAN-MEDA, Novartis, SANOFI-Genzyme-Regeneron, UCB Pharma, and Uriach Group.

Francisco Vega de la Osada has received speaker's honoraria from GSK, FAES, Chiesi, MSD, Bial, and Pfizer,

The remaining authors declare that they have no conflicts of interest.

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