Rhinology, 19, 231-236, 1981

# Committee report on standardization of rhinomanometry

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SUMMARY

*Current methods of rhinomanometry used by various workers from around the world were presented. The data for this communication is based on the work from the International Committee on Rhinomanometric Standards who presented their information at the 8th Congress of the European Rhinologic Society, October 21, 1980, in Bologna, Italy. These workers have an accumulation of approximately 42 years of experience with more than 10,000 rhinomanometric examinations. The results of this summary provide a consensus of methods, procedures, data collection and presentation which should be considered so that rhinomanometric uniformity may be achieved. It is well recognized that standardization of rhinomanometry still requires further inquiry and evaluation. This is not the final communication on the subject but merely a progress report and current consensus from a few workers in the field.*

## INTRODUCTION

This communication is an analysis of the current methods of rhinomanometry used by the various workers who comprise this committee and presented their work at the 8th Congress of the European Rhinologic Society in Bologna, Italy, October 21, 1980. The purpose of this work is to summarize some of the contemporary concepts and methods of rhinomanometry used internationally so that progress and development in this field of nasal physiology through rhinomanometry can continue in a conjoined fashion.

## METHODS AND MATERIALS

A questionnaire was sent to seven investigators who have worked in the field of rhinomanometry, most of whom have written extensively and have agreed to be members of the Rhinomanometric Standardization Committee.

The data for this communication is based on the questionnaires received from the following investigators, listed in alphabetical order: Dr. Per Broms (and associates, Dr. Bjorn Jonson and Dr. Lars Malm), Dr. P. A. R. Clement, Dr. Makoto

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Paper presented at the 8th Congress of the European Rhinologic Society and 2nd ISIAN, Bologna (Italy), October, 1980.

Hasegawa, Dr. Eugene B. Kern, Dr. A. E. Kortekangas, Dr. Hellmut Masing, and Dr. Kiyoshi Togawa. These seven workers represent approximately 42 years of experience and more than 10,000 rhinomanometric examinations have been performed under the guidance of these investigators. The persons administering these tests were either physicians or laboratory workers familiar with the equipment and procedures. In most instances, the tests were performed while the subject was sitting. On occasion, reclining and recumbent positions were also used during data collection.

## FINDINGS AND CONSENSUS

Most workers did not consider specific techniques to remove carbon dioxide or water vapor, primarily because the test situation was of short duration, although most thought that mask rhinomanometry, either anterior or posterior, was superior to the nozzle technique because the mask avoids disturbing the vestibule or valve when both pressure and flow are measured simultaneously. One investigator did use a vacuum in the mask for removal of $CO_2$ and water vapor during long investigational studies. Another warmed the pneumotachometer during the study session. The need for removal of $CO_2$ is suggested by the fact an increase in $CO_2$ decreases nasal patency. This has been studied in the human and the findings have been presented in the literature (McCaffrey and Kern, 1979). Most investigators had the patient hold the mask firmly to the face, although some used a headband to secure the mask to the patient's head.

There was no uniformity in transducers, as expected, because good pressure and flow transducers were easily available in each country represented. All workers observed the transnasal pressure and transnasal airflow relationship simultaneously on paper as a direct write-out tracing. Some also used the oscilloscope to evaluate the flow-pressure changes. Most workers had at least a two-channel recorder (two had two channel recorders, one had a three-channel recorder, two had four-channel recorder, and two used oscilloscopes).

Most workers calculated either nasal resistance or conductance. One interesting technique, advocated by Brom and associates (1980) essentially involved the use of a "mathematical mode" which is essentially a curve fitting process. In essence, they utilized three points at various radii on a scale plot and calculated the angle of the curve at the origin and a constant which is a factor of changing linearity.

The clinical and statistical mode concept was designed to normalize the data and allow interpretation of resistance. This method obviated the need to consider turbulence. The factor *c* which is really a measure of the rate of curvature is essentially ignored, except to mention that it is higher in patients with septal abnormalities. There are some interesting questions that have to be asked. Is it possible that one single parameter may be used to represent all noses? The second ques-

tion is, while measurements using anterior rhinomanometry provide clear curves for each nasal side, how can these separate curves be combined to assess total nasal resistance? This is an important question for any nonlinear system. Perhaps a true understanding of the various systems would be obtained by comparing all systems so that a particular model might provide better correlation with clinical data. This has yet to be done and is perhaps a question that can be asked for the next meeting of the International Committee on Rhinomanometric Standards.
Concerning recording conventions, almost all workers agree that on the *x–y* axis the *y*-axis (ordinate) is flow and is measured in liters per second. The *x*-axis (abscissa) is pressure and is measured in centimeters of water. Inspiration is downward deflection and experation is an upward deflection (Figure 1).
Most of the workers use a topical vasoconstrictor to eliminate the congestion of the nasal cycle. Almost all waited approximately 5 to 10 minutes before retesting the nose in the decongested state. One investigator stated that physical exercise induced a more physiologic nasal decongestion than vasoconstructor medication. Another interesting method was the oscillometer method to evaluate the data. Uninasal and total nasal resistance was calculated by all workers. One worker calculated nasal resistance at 0.2 liters per second flow and one calculated the nasal resistance at 1.5 cm of water pressure.
The symbol *P* was used for transnasal pressure change. The units most often used was centimeters of water although one investigator used millimeters of water. The symbol $\dot{V}$ was used for transnasal flow rate. The units most often used was liters per second although one worker used liters per minute. Nasal resistance was calculated most often in centimeters of water per liter per second.
Results of this survey provide a consensus that allows the following statements to be made considering uniformity in methods, procedures, data collection, and presentation.

1. Mask rhinomanometry (anterior or posterior mask techniques) which avoids the difficulties of anterior nozzle rhinomanometry was used and preferred by

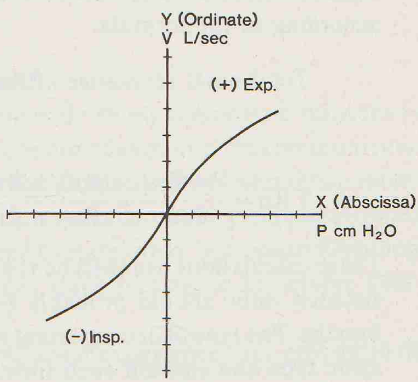


Figure 1. The *y*-axis (ordinate) is flow and is measured in liters per second. The *x*-axis (abscissa) is pressure and is measured in centimeters of water. Inspiration is a downward deflection and expiration is an upward deflection.

all workers. (The disadvantages of the anterior nozzle technique are possible distortion of the nasal valve and difficulty in obtaining an airtight seal in patients who had a caudal end septal deformity.) In addition, a posterior mask technique was advantageous when the patient had a septal perforation or a marked or complete uninasal obstruction.

2. Any type of anesthetic mask and readily available high quality gas or pressure transducers that can be adapted to that mask is acceptable.
3. Carbon dioxide and water vapor may affect the accuracy of prolonged mask studies (McCaffrey and Kern, 1979). Consequently, in short studies it probably does not make any difference to remove the $CO_2$ and water vapor; however, in long studies over 15 minutes, the $CO_2$ and water vapor should probably be removed.
4. An amplifier and strip chart recorder are mandatory so that at least a transnasal pressure and transnasal airflow may be studied concomittantly.
5. An oscilloscope is advantageous to study the flow-pressure loop to assure quiet unobstructed respiration (posterior rhinomanometry) but in addition to allow measurements at various points along the respiratory cycle.
6. Quiet respiration in a setting position was most often used and seems most appropriate. One investigator used various levels of recumbency and this is probably important when assessing allergic or vasomotor disturbances. Exercise tests and sleep positions are still in the investigative stages. Some consideration should be given to specific instructions before the patient is tested such as avoidance of nasal sprays, oral decongestants, and increased activity, just prior to examination. It is preferable to have the test administered by a physican or a laboratory person who is familiar with the procedures.
7. Consideration of age, sex, history and physical examination should be part of each study. Total nasal resistance (both sides) can be calculated directly from the binasal pressure and flow data (posterior mask technique). Total nasal resistance can be calculated from the uninasal pressure and flow data from the right and left side. Then the binasal or total nasal resistance can be calculated according to the formula:

$$\text{Total nasal resistance (TRn)} = \frac{1}{\dfrac{1}{Rn_{rt}} + \dfrac{1}{Rn_{lt}}} \quad \text{or}$$

$$TRn = \frac{\text{Product}}{\text{Sum}} = \frac{(Rn_{rt} \times Rn_{lt})}{Rn_{rt} + Rn_{lt}} \text{ in cm } H_2O/L/sec$$

These calculations can then be repeated after decongestion. Each uninasal resistance value should probably be based on the mean of four consecutive breaths. The type of decongestant is probably not as important as the use of the same type and amount each time.

One worker calculated resistance from the following formula:

$$W = \frac{\Delta P}{\dot{V}2} \cdot 10^3$$

He then calculated the total from the following formula:

$$W_{\text{total}} = W_r \cdot \frac{1}{1 + \frac{W_r}{W_l} + 2\sqrt{\frac{W_r}{W_l}}}$$

8. There is still no firm agreement as to where along the flow-pressure curve to make calculations of nasal resistance. The problems with using either fixed flow or fixed pressure points are that patients with disturbed nasal physiology may not be able to reach these points. One worker recommends utilizing a mathematical mode in order to obviate this problem. One question that must be answered in this regard is, should one single parameter be used to represent all noses? And, is the change in curvalinearity of the flow-pressure curve more important than a single point on that curve? Does a uninasal curve provide more information than a binasal curve? How should these curves be combined to assess total nasal resistance? A series of experiments should be undertaken in order to analyze data utilizing all current methodologies in order to arrive at more meaningful consensus and characterization of the flow-pressure curve.
9. Standardization of rhinomanometry requires further inquiry and re-evaluation.

   This is not the final communication on the subject but a current consensus from a limited few workers in the field. Certainly we apologize to those serious workers and students who may have been omitted from this inquiry; however, again upon request, I will send a questionnaire to any concerned scientist who has not been included. Perhaps at our next international meeting, answers to some of these basic questions will be presented and progress in rhinomanometry can continue onward.

## RÉSUMÉ

Cet article présente des méthodes courantes de rhinomanométrie utilisées par différents chercheurs partout au monde. Les données pour cette communication sont basées sur le travail du “International Committee on Rhinomanometric Standards” (comité international étudiant les standards rhinomanométriques), qui a présenté son information lors du 8ème Congrès de la “European Rhinologic Society” (société rhinologique européenne), qui s’est tenu le 21 octobre 1980 à Bologne, Italie.

Ces chercheurs ont accumulé à peu près 42 ans d’expérience avec plus de 10.000

examens rhinomanométriques. Les résultats du présent article fournissent un consensus sur les méthodes, procédures, le rassemblement et la présentation des données. Ce consensus devrait être pris en considération pour pouvoir réaliser une uniformité rhinomanométrique.

Il est bien reconnu que la standardisation de la rhinomanométrie demande de plus amples informations et évaluations. Ceci ne représente pas une publication définitive sur ce sujet, mais simplement un rapport de progrès et un consensus courant présenté par quelques chercheurs dans ce domaine.

## REFERENCES

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