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# A consideration of nasal, pulmonary and cardio-vascular interdependance and nasal-pulmonary function studies

*Maurice H. Cottle, Chicago, Illinois, U.S.A.*

SUMMARY

*Timed vital capacity of one second, peak flow, maximum breathing capacity (maximum voluntary ventilation), maximum middle half flow rate, total vital forced expiratory and inspiratory capacities, tidal and minute volume tested via the mouth and each "nose" separately for the diagnosis of nasal airway disturbance have proved to be valuable parameters of pulmonary function for the evaluation of the degree to which each nasal chamber "loads" the effort of breathing every breath in and out of the nose.*

*Minimum "normal" ratios of nose to mouth findings have been determined. Calculations falling below these normals indicate strongly the presence of significant nasal airway disturbance. Especially is this true when repeated testing yields constant similar results.*

The relation of nasal obstruction to the efficiency of lung function has long intrigued rhinologically oriented investigators. Samzelius-Lejdstrom (1939); Portman, Ferrari, and Pietrantoni as reported by Uddströmer (1940); Sercer (1936); and Ogura (1964) have particularly pointed out that nasal obstruction produces ipsolaterally diminished lung and thoracic movement and diminishes lung compliance regardless of whether the person breathes through the nose, the mouth, or via the trachea. They have also pointed out that improvement of restricted thoracic movement and diminished lung compliance occurred when the nasal obstruction was eliminated.

The neurologic connections between the nose and the thoracic organs have been anatomically and physiologically well documented (Mitchell, 1954; Allison, 1974) and are in a general way fairly well known and accepted.

The aforementioned authors show that there is clinical evidence that a naso-pulmonary neurological arc exists and that not only obstructed noses cause derangements, but other factors creating changes in the course and effects of the airstreams can produce reflex disturbances in the lung, the heart, and many other organs.

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Among other ill effects, nasal mucosa irritation may produce a change in blood flow, in blood pressure and electrocardiogram recordings. Chronic hypoventilation and hypoxia, often the sequellae of upper airway obstructions, can become irreversible even after the airway has been restored to normal. This may be due in part to the fact that aerobic metabolism of various tissues has been seriously deranged.

From Brown-Sequard (1858) to Krätchmer (1870) to DeBurgh Daly (1969), the effect of nasal mucosa stimulation and irritation of pulmonary, cardiac and vascular structures and functions has been experimentally definitively established by hundreds of authors (e.g. Kuttner, 1904). Drettner (1961), among others, has shown that cooling the extremities produces a diminution of blood flow through the nasal mucosa vessels and also lowers the temperature of the blood flowing through them even though the blood flow through the limbs being tested is cut off from the general circulation by tourniquets.

For the last ten years the literature is replete with incontrovertible evidence that nasal and naso-pharyngeal obstruction can be the cause of pulmonary hypertension, cardiomegaly, cardiac arrest, and even death. The many instances of young children with these symptoms permanently relieved by the removal of obstructing adenoids and/or tonsils is dramatic and convincing proof of the intimate relation between upper respiratory tract disturbance and serious heart and lung disease. (Edison et al., 1973; Omerovic, 1967; Nooran, 1965; Levy et al., 1967; Menashe et al., 1965).

In een recent study (Pepine et al., 1972) of twenty-five young men in the Naval Services with a tendency to anginal pain, stimulation and acceleration of the pulse rate to the point of producing angina created an accompanying series of heart and lung changes which were graphically recorded. Among these findings were myocardial ischemia, increased lower airway resistance and, surprisingly, a diminution of lung compliance. The latter is also the sequel of nasal obstruction, and clinical experience is suggesting very strongly that myocardial ischemia and concomitant chest pain (angina) can also be precipitated, if not altogether caused, by systemic derangements arising in some measure from nasal dysfunction.

The intimate relationship between heart and lung functions and their influence on arterial blood oxygen and carbon dioxide tensions, raises the question of whether a cardiac dysfunction with or without demonstrable lung changes would not actually create a variety of alterations in the patterns of breathing which would be reflected in the breathing pressure fluctuations of inhalation and exhalation measurable at the nostrils (Cottle, 1966). Six such alterations have long been observed and are worthy of further long-range study. One is the mid-cycle rest which is an apneic pause at the end of the positive pressure phase of each breath, frequently lasting a second or more. Second is a "trembling" or waviness of the respiratory curve especially during the time (one second or more) that the maximum of inspiratory is maintained. Third and quite notable is a shortened duration of maximum expiration (positive) pressure which changes from one to two seconds in time to just a peak lasting only a fraction of a second. Fourth is a marked increase in the amplitude of the pressure curves indicating a corresponding increase in the work of breathing through the nose. Fifth is a slow rate of breathing (less than ten per minute), low in amplitude, and irregular in form. Sixth is an increase of expiratory - positive - pressure amplitude exceeding the maximum inspiratory - negative - pressure which constitutes a reversal of the normal relationship.

## NASO-PULMONARY FUNCTION TESTS

Other correlations exist between nasal airway respiratory functions and lung functions. The nose normally interposes an obstruction to the air streams, a physiological necessity. The increase in resistance which it creates "loads" the work of breathing to its optimum efficiency. To measure this "loading" effect pulmonary function tests done (as is usual) via the mouth are compared with the same tests performed via each side of the nose with and without decongesting and/or anesthetizing the nasal mucous membrane. It is necessary to determine if the "loading" by each "nose" is excessive as can be deduced if the various naso-pulmonary parameters studied fall below an accepted percentage of the oral-pulmonary parameters. Each parameter has its own "normal" nasal percentage. In the presence of lowered percentages one must look for structural changes affecting the patency of the nasal airway, or alterations in nasal reflexes.

Pulmonary function tests done through a single nasal chamber and compared to the same test done through the other nose and also to those done via the mouth often disclose a poorly functioning nasal chamber which otherwise might escape detection. The tests may reinforce an opinion already drawn from other tests and examination. (Cottle, 1968).

Total vital capacity (T.V.C.), timed vital capacity of one second (T.V.C.$_1$), the ratio of the latter over the former (T.V.C./T.V.C.$_1$), peak flow, maximum breathing capacity (maximum voluntary ventilation), maximum middle half flow rate, inspiratory capacity, tidal and minute volumes, and rate of breathing are the parameters that often provide revealing information.

## METHODS

Naso-pulmonary function tests can be done in most hospitals and medical centers using their current wedge spirometers which, with proper modules and appropriate nozzles, can measure these parameters (Figure 1).

A pneumotachometer is often utilized connected to electronic devices sending a signal to a nearby computer or via the telephone to a distantly located computer

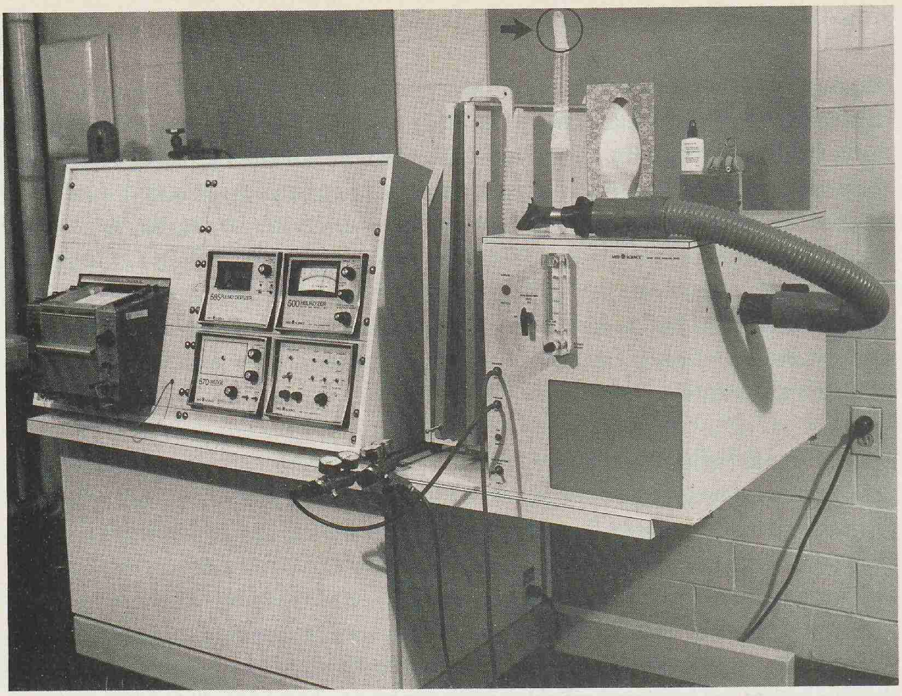

Figure 1. Wedge spirometer with modules. Arrow points to nozzle used for nasal testing. Note mucosal shrinking solution at top right corner of photograph.

Figure 2. Nozzle in left nose leads air to pneumotachometer. Information sent to distant computer via telephone.

Figure 3. Results of test being received via telephone from computer center.


Figure 4. Testing left nose via sensor connected to digital spirometer (Life Support Equipment Corporation).

(Figure 2) and from which a "read-out" is received in a few minutes at the site of the examination (Figure 3).

A digital spirometer (Life Support Equipment Corporation) (Figure 4) is available which electronically calculates immediately many pulmonary function parameters, certainly all those most cogent to our study.

Using mechanical non-electronic instruments such as manometers, pneumotachometers, peak flow meters, spirometers, and a stop watch, several parameters can be tested. Tidal volume, expiratory (vital) and inspiratory capacities, peak flow, timed vital capacity of one second (and its percentage of total vital capacity), maximum middle half flow rate, and maximum voluntary ventilation can be moderately well estimated which for office practice can serve as a rough screening process.

The tests are done in the same manner regardless of the apparatus used. For the mouth testing a mouthpiece is held in the mouth well sealed by the lips. Air is forcefully blown out into the spirometers in one continuous effort after the examinee has depleted his lung capacity to the fullest and taken a long deep breath. The nose is usually clamped off in this test. With a digital spirometer a special sensor is used instead of a pneumotachometer. With this sensor, occluding the nose is not necessary. The parameters are digitally displayed and recorded. For measuring inspiration capacity the process is reversed: the air is sucked in forcefully instead of being expelled.

For nose testing a nozzle of at least eight millimeters diameter is held snugly, but not forcefully, in one nasal vestibule while the other vestibule is closed off with a finger or the thumb. The blowing effort is then made through the nozzle as was done through the mouthpiece. After the findings are recorded the person is usually rested enough to undertake the testing of the other side of the nose.

Maximum voluntary ventilation (maximum breathing capacity) is determined in a separate procedure since it is the object of this test to learn how much air can be forced in and out of the lung in a given length of time approximately the same number of breaths. The mouthpiece and nozzle employed are those used for the forced expiratory and inspiratory tests.

Other pulmonary function parameters such as expiratory reserve volume, residual volume, total lung capacity, functional residual capacity that are routinely explored in pulmonary function studies have not as yet been adequately applied to rhinologic problems.

All respiratory function tests are so dependent on patients' cooperation and on the patience and cooperative competence of the examiner that it is necessary to repeat tests frequently, especially when marked divergence from the expected normals is found. In any case tests should be repeated not only during the initial examination, but also at subsequent times, after some rest, and after therapeutic management days or even weeks later.

One great advantage of naso-pulmonary function tests is that the nasal findings are being compared with the patient's own oral capacities at the moment rather than being judged according to data and statistics elaborated from studies done under differing circumstances on other people. Also, the right nose data are being compared with the left nose data which, in turn, are contrasted with the results obtained from the pulmonary function tests done via the mouth. All tests are thereby performed at about the same time under similar environmental and emotional circumstances. If the tests are to be quickly redone after the patient has rested a short period, the order in which the tests were originally done can be changed. This assures a greater dependability on an abnormal result that remains constant and consistent.

## DATA SUMMARY

From a series of more than four hundred studies, average "normal" percentage relationships between oral-pulmonary and naso-pulmonary tests in nine parameters* were calculated. In more than a thousand studies, "abnormal" or rather "subaverage" percentage findings were correlated with the nasal anatomic abnormalities seen before, during, and after medical treatment and/or surgical correction. Many persons were examined by two or even three methods, especially when severe aberrations were found.

The data in the following tables are of four parameters - timed vital capacity of one second, peak flow, maximum voluntary ventilation, maximum middle half flow rate - and are representative of the many tests performed before and after medical and/or surgical treatment. The ratio of the nose findings to those derived from oral examinations expressed in percentage considered to be minimal acceptable normals is indicated on each table. (Tables I–IV).

The ratio of timed vital capacity of one second to total vital capacity has often been found to be of diagnostic significance similar to the timed vital capacity of one second. However, if total vital capacity is abnormally low by the mouth test and the "nose" percentage high, a deduction of nasal normality is usually not valid.

In using total vital capacity, inspiratory capacity, tidal volume and minute volume as test parameters, the results obtained through a nose, both noses, the mouth, or any combination of orifices should not vary more than 20% in normal situations. If any of these four tests done via the nose is not 80% of what is found via the mouth, a significant nasal disturbance, anatomic or physiologic, must be sought.

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* Total expiratory vital capacity, inspiratory capacity, timed vital capacity one second, the ratio of timed vital capacity of one second to total vital capacity expressed in percentage, peak flow, maximum middle half flow rate, maximum voluntary ventilation, tidal volume, minute volume.

Table I. It is to be noted that in practically all the noses in which pathology was described before, during, or after operation, the nasal percentages were below the accepted normal of 40% and often markedly so. In cases numbered 56, 6, 5, 18, 16, 17, the "abnormal" side of the nose could be compared with the other "normal" side and the validity of this parameter as a diagnostic tool substantiated.

| Name | Sex | Age | Diagnosis | Mouth | Right nose | Left nose | R% | L% |
|---|---|---|---|---|---|---|---|---|
| A | F | 25 | Control | 3.46 | 2.35 | 2.30 | 67 | 66 |
| B | M | 50 | Control | 2.77 | 2.53 | 2.54 | 91 | 91 |
| C | F | 58 | Previous septum operation | 0.98 | 0.90 | 0.76 | 91 | 77 |
| D | F | 30 | Control | 3.24 | 2.27 | 2.14 | 70 | 66 |
| 31 | M | 75 | 40 years after SMR | 2.04 | 0.66 | 1.01 | 27 | 49 |
| | | | Myocardial infarction 1 year | | | | | |
| 1 | F | 65 | 5 years after SMR | 2.25 | 1.58 | 0.62 | 70 | 27 |
| | | | Myocardial ischemia 5 years | | | | | |
| 2 | M | 41 | Bilateral septum obstruction | 2.95 | 1.02 | 1.09 | 34 | 36 |
| 35 | F | 41 | After rhinoplasty | 2.25 | 0.83 | 1.40 | 36 | 62 |
| 34 | F | 56 | Nasal obstruction $PO_2$ 66 | 1.58 | 0.50 | 0.53 | 31 | 33 |
| 3 | F | 25 | Septum obstruction | 2.98 | 0.78 | 0.41 | 26 | 13 |
| | | | Retrobulbar neuritis | | | | | |
| 37 | F | 45 | Left valve stenosis | 2.23 | 1.34 | 0.59 | 60 | 26 |
| 37 | F | 45 | 3 months after surgery | 1.70 | 0.81 | 1.30 | 47 | 76 |
| 25 | M | 18 | Postoperative | 3.31 | 0 | 0.62 | 0 | 16 |
| | | | Perforation of septum | | | | | |
| 27 | M | 26 | After 3 nose operations | 3.56 | 1.38 | 1.54 | 38 | 43 |
| 55 | F | 27 | Septum obstruction | 2.83 | 0.62 | 0.79 | 21 | 27 |
| | | | Compression middle turbinates | | | | | |
| 56 | M | 17 | Right septum obstruction | 3.60 | 0.49 | 1.56 | 13 | 43 |
| | | | Nose leans to right | | | | | |
| 47 | M | 65 | Bilateral septum obstruction | 3.54 | 0.65 | 0.68 | 18 | 19 |
| 6 | M | 35 | Right septum and antrum pathology | 3.69 | 1.11 | 2.25 | 30 | 60 |
| 48 | F | 41 | Compression right middle turbinate; | 2.88 | 0.77 | 0.89 | 26 | 30 |
| | | | impaction left | | | | | |
| 5 | F | 23 | Right septum obstruction | 3.10 | 0.74 | 1.49 | 23 | 43 |
| 8 | M | 28 | Septum obstruction | 3.86 | 0.92 | 1.55 | 23 | 40 |
| 43 | M | 49 | After septum operation | 3.01 | 0.85 | 0.59 | 28 | 19 |
| | | | Possible antritis | | | | | |
| 14 | M | 66 | Septum obstruction | 3.81 | 0.99 | 0.77 | 25 | 20 |
| | | | Left antritis | | | | | |
| 16 | F | 59 | Left septum obstruction | 1.64 | 0.78 | 0.49 | 47 | 29 |
| 17 | F | 48 | Right septum obstruction | 2.31 | 0.71 | 1.27 | 30 | 54 |
| 18 | M | 21 | Compression left middle turbinate | 3.95 | 1.68 | 1.24 | 42 | 31 |
| 150 | F | 18 | Left ridge impaction | 3.50 | 1.30 | 0.60 | 37 | 17 |
| 152 | F | 66 | Left complete nasal obstruction | 2.00 | 0.80 | 0.30 | 40 | 15 |
| 102 | M | 32 | Bilateral impaction | 3.10 | 0.70 | 0.40 | 22 | 12 |
| 711 | M | 32 | Obstruction left vest. + valve | 4.80 | 1.30 | 0.40 | 27 | 8 |

Table II. Peak flow percentages are dependable data for evaluating the influence of nasal deformities on naso-pulmonary function. Cases numbered 32, 45, 56, 59, 63, 64, 72 are obvious examples.

| Name | Sex | Age | Diagnosis | Mouth | Right nose | Left nose | R% | L% |
|---|---|---|---|---|---|---|---|---|
| A | F | 25 | Control | 7.17 | 3.12 | 3.16 | 43 | 43 |
| B | M | 50 | Control | 6.51 | 3.22 | 4.26 | 49 | 64 |
| C | F | 58 | Septum correction 15 years | 2.23 | 1.17 | 1.33 | 52 | 59 |
| | | | No asthma | | | | | |
| D | F | 30 | Control | 8.70 | 2.47 | 2.67 | 28 | 30 |
| 31 | M | 75 | Submucous resection 40 years | 2.87 | 0.97 | 1.31 | 30 | 45 |
| | | | Myocardial infarction 1 year | | | | | |
| 28 | F | 62 | Septum obstruction | 5.51 | 1.11 | 1.20 | 20 | 22 |
| 2 | F | 56 | Septum obstruction $PO_2$ 66 | 3.08 | 0.64 | 0.68 | 20 | 22 |
| 37 | F | 45 | Left valve stenosis | 6.50 | 1.73 | 0.84 | 26 | 12 |
| 37 | F | 45 | 3 months after surgery | 3.02 | 0.92 | 1.68 | 30 | 55 |
| 16 | F | 59 | Left septum obstruction | 2.84 | 0.89 | 0.38 | 31 | 13 |
| 18 | M | 21 | Compression left middle turbinate | 9.73 | 2.27 | 1.15 | 23 | 11 |
| 19 | M | 65 | Right antritis | 7.23 | 1.49 | 2.56 | 20 | 35 |
| 21 | M | 53 | Bilateral antritis – office test | 13.21 | 1.41 | 2.29 | 10 | 17 |
| 21 | M | 53 | Bilateral antritis – hospital test | 12.17 | 0.82 | 2.47 | 6 | 20 |
| 25 | M | 18 | Right septum fractures | 7.73 | 0 | 0.62 | 0 | 16 |
| 52 | M | 51 | Postoperative | 6.54 | 0.51 | 0.80 | 7 | 12 |
| | | | Perforation of septum | | | | | |
| 32 | M | 31 | Impaction right septum | 8.91 | 0.98 | 2.16 | 10 | 24 |
| | | | Left ethmoiditis | | | | | |
| 28 | F | 62 | Septum obstruction | 5.51 | 1.11 | 1.20 | 20 | 21 |
| 15 | F | 49 | Postoperative atrophy with synechia | 5.76 | 0.56 | 1.46 | 9 | 25 |
| 15 | F | 49 | 2 months after cutting synechia | 4.42 | 1.12 | 1.17 | 25 | 26 |
| 42 | F | 42 | Septum obstruction (cardiac) | 5.10 | 0.63 | 0.59 | 12 | 11 |
| 45 | M | 40 | After septum operation | 11.34 | 3.56 | 1.42 | 31 | 12 |
| 55 | F | 27 | Septum obstruction | 5.39 | 0.77 | 0.92 | 14 | 17 |
| | | | Compression middle turbinates | | | | | |
| 56 | M | 17 | Right septum obstruction | 5.99 | 0.73 | 1.92 | 12 | 32 |
| | | | Nose leans to right | | | | | |
| 58 | M | 48 | Previous septum operation and | 10.15 | 2.18 | 1.87 | 21 | 18 |
| | | | anterior ethmoidectomy | | | | | |
| 59 | M | 70 | Correction of caudal end of septum | 7.27 | 0.85 | 2.44 | 11 | 33 |
| 63 | F | 16 | Right septum obstruction | 7.14 | 0.67 | 1.61 | 9 | 22 |
| | | | EKG 2+ | | | | | |
| 64 | F | 46 | Left septum obstruction | 7.07 | 1.75 | 1.25 | 22 | 14 |
| 67 | M | 22 | Bilateral septum obstruction | 10.11 | 0.83 | 1.81 | 8 | 17 |
| | | | Large adenoid | | | | | |
| 72 | F | 42 | Right antritis | 5.12 | 0.87 | 1.24 | 16 | 24 |
| | | | Pain in chest | | | | | |

Table III. Maximum voluntary ventilation (maximum breathing capacity) is for our purposes more useful and reliable than is commonly accepted by those working with pulmonary function tests. This is easy to understand since the attitudes and abilities of the patient to perform during the tests are modifying the result which is being compared with tables of statistics based on findings in other people. In naso-pulmonary investigations of the parameters useful in rhinology, the results are weighed only against the patient's own data acquired from the examination of the nose-lung function capabilities and his own mouth-lung function at about the same time and under the most similar environmental and psychological circumstances possible. In cases numbered 4, 46, 16, and 28, the maximum voluntary ventilation could not be performed before surgical correction of the nasal deformities was done. Cases numbered 47, 16, 18, 25, 13, 61 are illustrative of the frequency with which functional and morphological derangements can be correlated.

| Name | Sex | Age | Diagnosis | Mouth | Right nose | Left nose | R % | L % |
|---|---|---|---|---|---|---|---|---|
| A | F | 25 | Control | 151 | 70 | 58 | 46 | 38 |
| B | M | 50 | Control | 121 | 43 | 50 | 35 | 41 |
| C | F | 58 | Septum correction 15 years<br>No asthma | 40 | 22 | 17 | 55 | 42 |
| 31 | M | 75 | Submucous resection 40 years<br>Myocardial infarction 1 year | 69 | 45 | 40 | 65 | 57 |
| 2 | M | 41 | Bilateral septum obstruction | 104 | 32 | 13 | 30 | 12 |
| 47 | M | 65 | Right valve obstruction | 110 | 7 | 41 | 6 | 37 |
| 34 | F | 56 | Nasal obstruction $PO_2$ 66 | 47 | 14 | 10 | 29 | 21 |
| 3 | F | 25 | Septum obstruction | 104 | 21 | 9 | 20 | 8 |
| 46 { | M | 24 | Bilateral septum obstruction | 3+102 | – CANNOT DO – | | | |
| 46 | M | 24 | 7 weeks after surgery | 123 | 11 | 33 | 8 | 26 |
| 16 | F | 59 | Left septum obstruction | 56 | 15 | 0 | 26 | 0 |
| 18 | M | 21 | Compression left middle turbinate – right impaction | 147 | 40 | 21 | 27 | 14 |
| 19 | M | 65 | Right antritis | 142 | 18 | 42 | 12 | 29 |
| 20 | F | 44 | Migraine – septum obstruction sinus infection | 112 | 18 | 11 | 16 | 9 |
| 21 { | M | 53 | Bilateral antritis-office test | 128 | 20 | 28 | 16 | 22 |
| 21 | M | 53 | Bilateral antritis-hosp. test | 198 | 31 | 44 | 15 | 22 |
| 25 | M | 18 | Right septum fractures | 155 | 0 | 24 | 0 | 15 |
| 26 | M | 46 | Previous rhinoplasty | 115 | 31 | 15 | 26 | 13 |
| 27 | M | 26 | After 3 nose operations | 150 | 27 | 32 | 18 | 21 |
| 30 | F | 44 | Chest pain – mid-cycle rest | 134 | 39 | 51 | 29 | 38 |
| 28 | F | 62 | Could not do tests before oper.<br>This test 3 mo. after oper. | 54 | 9 | 18 | 16 | 33 |
| 4 | M | 15 | Could not do tests before oper.<br>4 mo. after septum correction | 13 | 19 | 21 | 100+ | 100+ |
| 44 { | M | 25 | Bilateral septum obstruction | 239 | 41 | 28 | 17 | 11 |
| 44 | M | 25 | Bilateral septum obstruction with predicted mouth finding | 142 | 41 | 28 | 28 | 19 |
| 13 | M | 48 | Right septum obstruction | 108 | 8 | 60 | 7 | 55 |
| 47 | M | 65 | Right septum obstruction | 110 | 7 | 41 | 6 | 37 |
| 8 | M | 28 | Bilateral septum obstruction | 110 | 8 | 22 | 7 | 22 |
| 13 | M | 48 | After septum operation<br>suspect antritis | 113 | 11 | 3 | 9 | 2 |
| 11 | | E.C. | Left mid-cycle rest | 58 | 27 | 2 | 46 | 3 |
| 61 | M | 19 | Marked left septum obstruction | 216 | 81 | 31 | 37 | 14 |

Table IV. Maximum middle half flow rate cases numbered 6, 7, 46, 27, 8, 17, 19, and others demonstrate how useful comparing the tests of the two sides of the nose can be in nasal diagnosis. Also suggested in cases numbered 81 and 82 is a method for observing the effect of thorough mucosal anesthesia on pulmonary function in some patients.

| Name | Sex | Age | Diagnosis | Mouth | Right nose | Left nose | R% | L% |
|---|---|---|---|---|---|---|---|---|
| 50 | M | 27 | Control | 4.64 | 3.03 | 2.25 | 65 | 48 |
| 51 | M | 48 | Control | 3.85 | 1.96 | 1.60 | 51 | 55 |
| 57 | M | 55 | Control | 1.57 | 1.13 | 1.18 | 71 | 75 |
| 68 | F | 39 | Control | 3.03 | 2.14 | 1.91 | 70 | 63 |
| 52 | M | 51 | Postoperative Perforation of septum | 3.02 | 0.28 | 0.38 | 9 | 12 |
| 62 | F | 53 | Previous septum operation | 3.70 | 0.80 | 1.10 | 21 | 29 |
| 67A | M | 22 | 3 weeks after conservative septum pyramid surgery | 4.53 | 0.78 | 1.43 | 17 | 31 |
| 72 | F | 42 | Right antritis Pain in chest | 3.43 | 0.61 | 1.15 | 17 | 33 |
| 3 | F | 25 | Bilateral septum obstruction | 3.05 | 0.74 | 0.46 | 24 | 15 |
| 7 | F | 55 | Right septum obstruction Compression left middle turbinate | 2.25 | 0.89 | 0.17 | 39 | 7 |
| 2 | M | 41 | Bilateral septum obstruction | 2.28 | 0.59 | 1.00 | 25 | 43 |
| 47 | M | 65 | Anterior right septum obstruction | 3.14 | 0.57 | 0.57 | 18 | 18 |
| 15 { | F | 49 | Postoperative atrophy with synechia | 2.49 | 0.49 | 1.30 | 19 | 53 |
| 15 | F | 49 | 2 months after cutting synechia | 2.60 | 1.02 | 0.99 | 39 | 36 |
| 6 | M | 35 | Right antritis | 5.30 | 1.82 | 2.73 | 33 | 51 |
| 8 | M | 28 | Bilateral septum obstruction | 4.18 | 0.75 | 1.64 | 17 | 39 |
| 17 | F | 48 | Right septum obstruction | 2.84 | 0.65 | 1.14 | 22 | 40 |
| 19 | M | 65 | Right antritis | 3.21 | 1.11 | 2.26 | 34 | 70 |
| 46 | M | 24 | 7 weeks after septum surgery | 2.83 | 0.79 | 1.21 | 27 | 40 |
| 27 | M | 26 | After 3 nose operations | 4.23 | 1.21 | 1.94 | 28 | 45 |
| 60 | F | | Septum obstruction | 3.16 | 1.03 | 0.93 | 32 | 29 |
| 79 | M | 38 | Previous rhinoplasty | 5.92 | 0.71 | 2.84 | 11 | 47 |
| 80 | F | 19 | Infantile lobule | 2.92 | 0.53 | 1.08 | 18 | 34 |
| 81 { | M | 72 | After septum and antrum surgery | 1.88 | 0.68 | 0.63 | 36 | 33 |
| 81 | M | 72 | After cocainization | 1.43 | 0.69 | 0.99 | 48 | 69 |
| 82 { | F | 72 | Left septum obstruction | 1.96 | 1.18 | 0.23 | 60 | 11 |
| 82 | F | 72 | After cocainization | 1.42 | 0.95 | 0.17 | 66 | 11 |
| 84 | F | 33 | Previous rhinoplasty | 3.51 | 0.28 | 1.07 | 7 | 30 |
| 29 { | F | 29 | Postoperative saddling | 2.54 | 0.77 | 0.54 | 30 | 21 |
| 29 | F | 29 | 3 weeks after implant | 2.04 | 1.13 | 0.84 | 55 | 41 |

WORK SHEET REPORTS

The following reports show naso-pulmonary function tests in a normal nose (Case Report 1), in one with a unilateral nasal obstruction (Case Report 2), in one with a bilateral nasal obstruction (Case Report 3), in one of an obstructed nose before and after surgical correction (Case Report 4), and one in which the tests on one side could not be performed at all because of marked soft as well as hard tissue obstruction (Case Report 5, part 1). In the last patient, a test five weeks after surgical and medical treatment is also shown (Case Report 5, part 2).

Case Report 1.

PATIENT'S NAME A.R. (female) DATE: 5/30/75

DOCTOR: AGE: 62 HT 5'2" WT. 112

BED NO. HOSP. NO.

DIAGNOSIS No symptoms. After 6 nose operations.

**Naso-pulmonary function tests**

| | MOUTH | RIGHT NOSE | LEFT NOSE | R % | L % | NORM |
|---|---|---|---|---|---|---|
| TIDAL VOL. (L) | 500 | 400 | 450 | 80 | 90 | 80% |
| VITAL CAPACITY (L) | 2.7 | 2.3 | 3.3 | 85 | 100+ | 80% |
| TIMED V.C. (1 sec.) | 2.3 | 1.9 | 1.8 | 82 | 78 | 40% |
| PEAK FLOW (L/sec.) | 8.5 | 2.6 | 2.2 | 30 | 25 | 25% |
| M.V.V. (L/min.) | 76 | 32 | 43 | 42 | 56 | 35% |
| M.M.H.F. (L/sec.) | 3.8 | 2.1 | 1.7 | 55 | 44 | 45% |
| T.V.C.$_1$/V.C. (%) | 88 | 83 | 56 | 94 | 63 | 40% |
| INSPIRATORY CAP. (L) | | | | | | 80% |

Case Report 2.

PATIENT'S NAME B.R. (female) DATE: 10/13/75

DOCTOR: AGE: 24 HT. 5'3" WT. 110

BED NO. HOSP. NO.

DIAGNOSIS Left septal obstruction

**Naso-pulmonary function tests**

| | MOUTH | RIGHT NOSE | LEFT NOSE | R % | L % | NORM |
|---|---|---|---|---|---|---|
| TIDAL VOL. (L) | 350 | 300 | 120 | 86 | 34 | 80% |
| VITAL CAPACITY (L) | 2.8 | 3.0 | 2.4 | 107 | 85 | 80% |
| TIMED V.C. (1 sec.) | 2.5 | 1.4 | 0.3 | 56 | 12 | 40% |
| PEAK FLOW (L/sec.) | 3.7 | 1.9 | 0.7 | 51 | 18 | 25% |
| M.V.V. (L/min.) | 72 | 29 | 12 | 40 | 16 | 35% |
| M.M.H.F. (L/sec.) | 3.3 | 1.5 | 0.4 | 45 | 12 | 45% |
| T.V.C.$_1$/V.C. (%) | 91 | 47 | 16 | 51 | 17 | 40% |
| INSPIRATORY CAP. (L) | | | | | | 80% |

Case Report 3.

PATIENT'S NAME L.K. (male) DATE: 1/2/76

DOCTOR: AGE: 44 HT. 5'7" WT. 175

BED NO. HOSP. NO.

DIAGNOSIS Bilateral septum obstruction

**Naso-pulmonary function tests**

| | MOUTH | RIGHT NOSE | LEFT NOSE | R % | L % | NORM |
|---|---|---|---|---|---|---|
| TIDAL VOL. (L) | | | | | | |
| VITAL CAPACITY (L) | 5.2 | 3.5 | 4.4 | 67 | 84 | 80% |
| TIMED V.C. (1 sec.) | 3.7 | 0.5 | 0.4 | 13 | 10 | 40% |
| PEAK FLOW (L/sec.) | 7.9 | 1.3 | 1.0 | 16 | 12 | 25% |
| M.V.V. (L/min.) | 109 | 41 | 23 | 38 | 21 | 35% |
| M.M.H.F. (L/sec.) | 3.0 | 1.0 | 0.9 | 33 | 30 | 45% |
| T.V.C.$_1$/V.C. (%) | 72 | 17 | 10 | 23 | 13 | 40% |
| INSPIRATORY CAP. (L) | | | | | | 80% |

Case Report 4.

PATIENT'S NAME C.R. (female) DATE: 8/29/75
DOCTOR: AGE: 46 HT. 5'4" WT. 129
BED NO. HOSP. NO.
DIAGNOSIS Septum obstruction, crowding left nasal chamber

**Naso-pulmonary function tests**

| | MOUTH | Before Operation R % | Before Operation L % | After Operation R % | After Operation L % | NORM |
|---|---|---|---|---|---|---|
| TIDAL VOL. (L) | | (480) | (800) | (400) | (600) | |
| VITAL CAPACITY (L) | | + | 85 | + | + | |
| TIMED V.C. (1 sec.) | | 43 | 11 | 53 | 70 | 40% |
| PEAK FLOW (L/sec.) | | 28 | 11 | 26 | 32 | 25% |
| M.V.V. (L/min.) | | 21 | 21 | 28 | 35 | 35% |
| M.M.H.F. (L/sec.) | | 46 | 11 | 33 | 37 | 45% |
| T.V.C.₁/V.C. (%) | | 30 | 20 | 39 | 43 | 40% |
| INSPIRATORY CAP. (L) | | | | | | 80% |

Case Report 5, part 1.

PATIENT'S NAME R. G. (male) DATE: 10/1/75
DOCTOR: AGE: 19 HT. 6' WT. 185
BED NO. HOSP. NO.
DIAGNOSIS Bilateral septum obstruction with vasomotor rhinitis.

**Naso-pulmonary function tests**

| | MOUTH | RIGHT NOSE | LEFT NOSE | R % | L % | NORM |
|---|---|---|---|---|---|---|
| TIDAL VOL. (L) | | 0 | 850 | | | |
| VITAL CAPACITY (L) | 4.7 | C | 4.3 | C | 91 | 80% |
| TIMED V.C. (1 sec.) | 3.6 | A | 1.0 | A | 27 | 40% |
| PEAK FLOW (L/sec.) | 6.5 | N | 1.4 | N | 21 | 25% |
| M.V.V. (L/min.) | 62 | N | 22 | N | 35 | 35% |
| M.M.H.F. (L/sec.) | 3.5 | O | 0.8 | O | 22 | 45% |
| T.V.C.₁/V.C. (%) | 76 | T | 30 | T | 39 | 40% |
| INSPIRATORY CAP. (L) | | | | | | 80% |

Case Report 5, part 2.

PATIENT'S NAME R. G. (Male) DATE: 1/10/76
DOCTOR: AGE: 20 HT. 6' WT. 180
BED NO. HOSP. NO.
DIAGNOSIS 5 weeks after total submucous resection and reconstruction of nasal septum. Untreated nasal allergy.

**Naso-pulmonary function tests**

| | MOUTH | RIGHT NOSE | LEFT NOSE | R % | L % | NORM |
|---|---|---|---|---|---|---|
| TIDAL VOL. (L) | | | | | | |
| VITAL CAPACITY (L) | 3.5 | 2.5 | 2.5 | 71 | 71 | |
| TIMED V.C. (1 sec.) | 72 | 16 | 28 | 33 | 38 | 40% |
| PEAK FLOW (L/sec.) | 3.7 | 0.6 | 1.0 | 16 | 27 | 25% |
| M.V.V. (L/min.) | | | | | | 35% |
| M.M.H.F. (L/sec.) | 2.4 | 0.4 | 0.7 | 20 | 29 | 45% |
| T.V.C.₁/V.C. (%) | 72 | 16 | 28 | 33 | 38 | 40% |
| INSPIRATORY CAP. (L) | | | | | | 80% |

## CONCLUSION

People who have marked subjective nasal symptoms often exhibit anatomical derangements that could account for these symptoms, but certainly not always. Objective functional tests to corroborate opinions of nasal derangements are becoming more widely utilized. Pressure and resistance studies have long been well known and now naso-pulmonary function tests have become a serviceable addition to nasal breathing pressure-flow evaluations.

Many patients show subjective and objective (functional) evidence of improvement shortly after medical and/or surgical treatment.

Post-operative studies occasionally reveal no improvement of the objective findings even when the symptoms complained of have been relieved. This indicates strongly that disturbed respiratory patterns, reflexes, and relationships are not always immediately and entirely affected by therapeutic surgical and medical procedures even though these be well chosen and well done. In some of these patients improvement in tests did not occur until several years after surgery.

An absence of post-operative improvement of laboratory tests may also be suggesting strongly that not all of the pathology was uncovered, removed, or otherwise corrected at the time of surgery, or that some additional medical and/or surgical care is called for. This may be true even if the patient feels clinically improved.

In a small number of patients whose severe symptoms were relieved by removal of nasal deformities, no pre-operative or post-operative disturbances of nasal and/or naso-pulmonary function tests were definitively established. This can be confusing, but at present no nasal function tests can be classed as absolutely constant or pathognomonic.

## RÉSUMÉ

Dans le but d'évaluer la charge apportée par chaque fosse nasale (à l'inspiration et à l'expiration) à l'effort respiratoire et pour le diagnostic des perturbations dynamiques nasales, un certain nombre de paramètres de la fonction pulmonaire sont étudiés non seulement en respiration buccale, mais aussi en respiration nasale séparément au niveau de chaque fosse.

Les paramètres suivants se sont révélés précieux: capacité vitale par seconde, débit de pointe, capacité respiratoire volontaire maximale, taux du débit moyen maximum, capacité vitale totale inspiratoire et expiratoire, volume courant et volume par minute.

On a déterminé le niveau normal minimum des rapports de ces paramètres du nez par rapport à la bouche. Les chiffres situés au-dessous des niveaux de référence indiquent fortement une perturbation nasale significative. Cela est particulièrement vrai lorsque des tests répétés fournissent des résultats similaires.

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Maurice H. Cottle, M.D.
Illinois Masonic Medical Center
836 West Wellington Avenue
Chicago, Illinois 60657
U.S.A.