The Problem of the Visceral Function of the Lungs

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During the past two decades great strides have been made in the development of modern pulmonary physiology. But in these, some fundamental deficiencies have also been revealed indicating that current concepts are inadequate in explaining the increasing complexity of the recently observed phenomena of lung function and dysfunction. The point has now been reached when the need of a new concept, namely that of a special (visceral) function of the lungs is becoming increasingly apparent. Such a concept was proposed by the writer nearly two decades ago.¹

Recent developments justify the assumption of a visceral function of the lungs, at least as a working theory, affording logical answers to some unsolved problems of pulmonary function and dysfunction.

In this discussion, four aspects will be considered:

I. The nonbiological character of present concepts of lung function.
II. Possible manifestations of visceral lung function as interpreted from the relationship between pulmonary structure and function.
III. Unsolved problems not adequately explained by prevailing concepts, but which logically point toward visceral lung function.
IV. Inferences regarding a specific hormone controlling lung function.

I. The Nonbiological Character of Present Concepts of Lung Function:

Analysis will show that prevailing ideas about lung function do not adequately explain recent observations chiefly because they are much too mechanistic. They labor under the presumption that all of lung function can be seen and measured in ventilation, circulation and gas exchange. The denial of a true organic function of the lungs implied in this presumption is its inherent defect. This peculiarly nonbiological character of modern concepts about lung function could hardly be better expressed than by the words of the late eminent physiologist Y. Henderson: "The lungs are peculiar organs in that they have little independent activity or self-regulation."² This obviously referred to the fact that since ventilation is the activity of the neuromuscular apparatus in the chest wall and diaphragms, since the pulmonary circulation is driven by the heart, and since pulmonary gas exchange is a physiochemical process taking place automatically, the structures of the lungs are not presumed to have any activity of their own.

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Exception to this should be noted in current writings where the activity of one structure of the lungs is again being stressed, namely the role of its myoelastic apparatus in the elastic recoil during expiration. Many workers now look upon this as the sole and chief function of the lungs, which was well described in the following statement.3

"Mechanically the function of the lungs is more simple than that of any other vital organ . . . About half a million times during life in the act of inspiration the lung is passively stretched—half a million times in the act of expiration it must recoil—. This recoil is analogous to cardiac systole and is accomplished by virtue of inherent pulmonary elasticity . . . . Failure of systole is the essence of the commonest form of chronic lung failure."

Reasoning from this the same author concluded logically by comparing the function of the lungs to that of "tire tubes of trucks." Far fetched as that may sound, it is yet true that current concepts have led to such an absurd conclusion of a mechanistic nature of lung function that comparison with lifeless rubber appears quite natural.

It should be noted here how the pendulum in the evolution of pulmonary physiology has swung from one extreme to the other. Biological thinking naturally led the pioneers in this field to the conviction that the organic function of the lungs should manifest itself in an active role in gas exchange. Hence Pflueger, Bohr, and Haldane were led to assume an active gas secretion by the alveolar epithelium. This idea was abandoned when Krogh, Bancroft and their followers demonstrated the purely physico-chemical nature of gas exchange in the lungs. After that the pendulum swung from vitalistic far over to mechanistic thinking. In that transition from one to the other extreme a strange vacuum of ideas arose and remained quite unnoticed, as no idea came forward regarding some other possible role of the lungs' structures in gas exchange. Since then modern pulmonary physiology has become so deeply steeped in its nonbiological thinking that there is not even any awareness of the implication that the most vital organ of the body, next to the heart, is presumed to have no function of its own in the strict sense of that term.

II. Possible Manifestations of Visceral Function of the Lungs:

Because of lack of awareness of the meaning of visceral lung function it becomes necessary to present here briefly the writer's concept of this as proposed nearly two decades ago. This was intended to fill the vacuum in biological thinking about the function of the lungs as a vital organ of the body. It adheres to the principle that the organ-function of the lungs should have an active role in gas exchange. It proceeds from the fact that gas exchange in the lungs is ultimately a matter of the quantity as well as of the quality of the contact surface between blood and air in the air-spaces of the lungs. These considerations led to the idea that "creation of breathing surface" by the structures of the lungs is the essence of their visceral function. In detail this concept assumes that breathing-surface-creating activity is invested in the ultimate structural units of the lungs. This activity involves changes in the consistency of the semi-fluid membrane
covering the breathing surface, which allows the momentarily perfused capillaries to extend forward into the air-spaces. This activity of the breathing surface structures (capillaries and alveolar walls) results in simultaneous increase not only in the extent of the diffusing surface but also implies changes in its quality, i.e., permeability. These changes constantly serve to adapt the breathing surface to the momentary requirements of the body.

Some of the phenomena which may be logically interpreted as manifestations of visceral lung function of a type just described are as follows:

1. **Intranatal establishment of lung function.** In the whole wide field of biology there is no more fascinating phenomenon, and no greater miracle wrought by nature, than the establishment of lung function during birth. The process by which this is brought about involves the following two cardinal changes: (1) The pulmonary capillaries upon first being perfused spring forward and with the force of the surging blood-flow, bulge into the air-spaces just created under the effect of the expanding chest. (2) The membrane covering the air-spaces so created undergoes changes in consistency and continuity allowing the forward extension of the capillaries. This process results in the creation of a breathing surface of such extent and quality as to permit the most intimate contact between the blood in the capillaries and the gases in the air-spaces. Thus the fundamental process implied in intranatal establishment of lung function is "breathing surface creation."

2. **Relationship between structure and function** as applied to the lungs. Since it is the function of the lungs to afford the most adequate surface for efficient gas-exchange, conceivably the most purposeful activity of its structures must be one of actually creating such surface. It is an accepted biological principle that structure and function are always and everywhere intimately related. If surface creation is the true function of the lungs' structures, then this should be clearly indicated in the features of these structures. This principle is indeed valid for the structures of the lungs, perhaps more than in the case of most organs of the body. Structure and function are here but two facets of the same phenomenon whereby function begets structure and structure begets function. Function consists here of breathing-surface creation by structural changes which result in the creation of that surface. The structural manifestations of this are: (a) active bulging forward of the capillaries into the air-spaces. (b) Consistency changes in the breathing surface membrane. The former was emphasized

**Footnote:** The concept of visceral lung function outlined above was published (Annals of Internal Medicine, March 1938) in a joint publication with Dr. J. A. Miller, who will be remembered as the founder of the famous research center for pulmonary function studies at Bellevue Hospital. Since this center has played a historical role in the progress of modern pulmonary physiology, it may be of interest to note here that Dr. Miller established this research center upon the initiative of the writer and that these concepts of "intrinsic lung function" inspired his deep interest in those lung function studies which have born rich fruit in the remarkable pioneer achievements of Dr. Cournand and his associates in cardiac catheterization, and in the outstanding work of Dr. Richards and his associates in pulmonary physiology.
by the observations of Macklin. The latter has been stressed especially by Bremer and confirmed in recent observations of Hayek.

These are naturally only inferences from features in fixed histological specimens. But, what we see of the lungs' ultimate structures in fixed histologic features should lead us to infer that they are mere reflections of a constant and extraordinary mobility implied in the type of structural activity assumed for "visceral lung function." It should be emphasized in this connection that this structural activity is more inaccessible to demonstration "in vivi" in the case of the lungs than in that of any other organ of the body. The lungs are the most dynamic organ of the body. Two significant facts should illustrate this point. (1) In spite of prodigious efforts we have never succeeded in visualizing the capillary circulation in the lungs "in vivo" by the methods which have been eminently successful in visualizing the capillary nets of all other viscera. This negative evidence has led Barclay to ask the question "whether the capillaries of the lungs lying virtually among air-spaces at atmospheric pressure are different in some way from capillaries that are supported in solid organs."

The nature and the functional changes of the membrane covering the breathing surface has been under dispute among histologists for a long time. It may be present in one place and absent in the next, it may be a thick membrane in one place and a barely discernible thin diaphanous semi-fluid membrane in the next. The alveolar capillaries and the alveolar membrane have proved to be the most elusive structures in the body, facts which should lead us to infer that their activity is a most unusual one.

III. Unsolved Problems of Pulmonary Physiology:

Let it be emphasized at this point that the concept of visceral lung function is not intended to replace any of the established principles of pulmonary physiology. Visceral lung function is conceived as supplementing the established facts of ventilation, circulation and gas-exchange where these have proved inadequate to explain observations on pulmonary function and dysfunction. Admittedly the concept of visceral lung function is wholly theoretical and based on assumptions but these are applied to the part of lung function which has remained inaccessible to observation and measurement even by the most refined techniques of modern pulmonary physiology. Characteristically current explanations become inadequate when dealing with changes which take place in the structures of the lungs and indicate an active role of the latter in the local regulation of ventilation, circulation and gas-exchange. These unsolved problems of pulmonary physiology to say the least justify the concept of visceral lung function with all its assumptions as a working theory. Indeed, these unsolved problems point up the presumption implied in prevailing concepts that the lungs have no organ-function of their own. Perhaps the best examples of this are the following two basic problems of modern pulmonary physiology:

(1) Correlation of ventilation and circulation throughout all parts of the lungs.
(2) Correlation of diffusing capacity with momentary requirements of the body. Concerning these the following comments are to be made here:

(1) Correlation of ventilation and circulation throughout the lungs. Recent experimental and clinical studies have demonstrated precise correlation of ventilation and circulation throughout all parts of the lungs. Implied in this correlation is the existence of a functional mechanism which operates in such a manner that blood-flow through various parts of the lungs is always distributed according to the efficiency of aeration; and vice versa the ventilation of the different parts of the lungs is always in proportion to the blood flow reaching the particular lung areas. The exact nature of this most remarkable functional mechanism remains to be determined. So much is obvious however that such precise local correlation of circulation and ventilation throughout all parts of the lungs must be based on a most purposeful function operating with the structures of the ultimate organ units. Involved in this function there must be a precise control of the lumina of arterioles and bronchioles under the effect of local tension levels of the gases in the blood reaching the capillaries and in the air inhaled into the air-spaces.

That such a correlation exists between ventilation and circulation throughout all parts of the lungs was predicted by the writer as far back as 1929 in the following statement: "It is a basic principle of pulmonary function that in any unit of the lungs there can be no circulation without ventilation and that there can be no ventilation without circulation. It is this precise correlation between ventilation and circulation that underlies the mechanism set in action with all variations in respiratory requirements ... One must assume that this correlation is as precise in each unit of the lungs as it is in the whole of it." In contrast in prevailing concepts of modern pulmonary physiology it was taken for granted that nearly equal distribution of ventilation and circulation throughout all parts of the lungs is prerequisite for normal efficiency of gas-exchange. Maldistribution of ventilation and circulation throughout various parts of the lungs was therefore assumed to be the chief manifestation of abnormal function. Estimation of "distribution disturbance" became the clue to the study of pulmonary dysfunction.

It has been demonstrated that unequal distribution of the ventilation and circulation throughout various parts of the lungs is indeed the normal condition prevailing in the lungs. The significance of this has been described as follows: "Uneven ventilation is not necessarily a deviation from physiologically ideal conditions. Variations in the ventilation rate of different regions of the lungs when properly integrated with perfusion may well permit a respiratory adaptability to various conditions which would otherwise interfere with gas-exchange. The existence of uneven alveolar ventilation emphasizes that the lungs and breathing apparatus are not a simple or necessarily homogeneously functioning system. This indicates a potential inadequacy of many concepts which so assume, or which have arisen from methods that measure the net effect of the components. Physiological common-
places such as 'the alveolar' ventilation (or blood flow) is X liters/minute" and 'anoxia (or nerve action) contracts pulmonary vessels' represent net effects which may or may not be representative of events in all regions of the lungs."

Not only have prevailing concepts of lung function failed to explain the mechanism of correlation of ventilation and circulation unevenly distributed throughout the lungs, but as indicated by the above statement from a foremost worker these recently emerged observations cast doubt upon some of the basic tenets of modern pulmonary physiology. In passing it should be mentioned here that the existence of this mechanism has been questioned in turn by another leading worker13 who recently asked "if such a purposeful, homeostatic mechanism regulating locally the alveolar ventilation—perfusion relationship exists—why in chronic pulmonary disease where this mechanism could be of great value, the lack of coordination between local ventilation and local perfusion is one of the main causes of physiologic disorders." The answer to this question is obvious from biological reasoning that it lies in the very nature of disease to interfere with normal regulation. Pathologic conditions will naturally result in disturbance of the normal correlation between ventilation and circulation in various parts of the lungs.

Such precise correlation of ventilation and circulation throughout all parts of the lungs operating with the ultimate structures of its organ units could hardly be conceived in any other way than by the assumption of a type of structure activity which practically implies "visceral lung function." It hardly needs to be pointed out, on the other hand, that it lies in the very nature of any concept of "visceral lung function" that ventilation and circulation throughout all parts of the lungs must be precisely correlated with it to secure its efficient operation.

Obviously such a functional mechanism implies regulation of structural (vasomotor and bronchomotor) activities in precise correlation with "visceral function" throughout all parts of the lung. Indeed the so-called N-lung experiments of Jacobaeus, about 15 years ago,14 should have led us to suspect that the normal gas content of the air inhaled probably plays a role in this regulation. More recent observations15 have actually confirmed the fact that the O₂ content of the air inspired and the venosity of the bolod returned to the lungs are factors involved in the correlation of ventilation and circulation throughout all parts of the lungs. All of which constitutes a true visceral autonomy in the manner of other visceral functions in the body. This visceral autonomy operates with such precision that venous blood returning to the lungs finds its way to the just freshly aerated breathing surface; and the fresh air just inhaled into the lungs finds its way to the capillary surface in which venous blood freshly arrived is most in need of gas exchange. It goes without saying that under pathologic conditions this functional mechanism becomes upset resulting in the manifestations well known to us from modern physiologic studies.

(2) Correlation of diffusing capacity of the lungs with momentary gas exchange requirements of the body. There is perhaps no other phase of
modern pulmonary physiology where the inadequacy of current views is more apparent than in the question of how diffusing capacity of the lungs is constantly adapted to the gas exchange requirements of the body. A review of the present status of this question in current literature should serve to illustrate the great difficulties into which mechanistic thinking has led in the solution of this problem. The following quotation from a most recent publication, perhaps best illustrates the point in question.16

"The most convincing evidence for functional changes in the pulmonary membrane is provided by the increase in diffusing capacity which occurs with exercise. The fact that such an increase occurs has been demonstrated repeatedly both in normal subjects and in patients with mitral disease. The explanation would seem to require either that the permeability to oxygen of the diffusing surface increase with exercise, or that its area broaden. While no proof is available, it seems likely that the area of the perfused portion of the pulmonary capillary bed might increase, but unlikely that the diffusion characteristics of the capillary walls and alveolar membrane should change. From these reasonable assumptions it is postulated: 1) That during exercise the area of the active diffusing surface increases; 2) conversely, that part of the surface, across which diffusion takes place during exercise, is inactive in the resting state; and 3) that this reduction results, in large measure, from the cutting off of blood flow through portions of the capillary bed.

"A way in which such dynamic changes in the diffusing surface might be brought about is suggested by the work of Burton, Nichols, Girling, Jerrard, and Claxton. These workers inferred, from careful studies of the circulation of the rabbit's ear and hind limb, that small vessels close completely at pressures below a certain level, called the critical closing pressure. They also found evidence that the critical closing pressure rises as the tone in the vessel walls increases.

"If these ideas are applied in the case of mitral stenosis, it would seem possible that some of the small pulmonary vessels close in the resting state because the pressure tending to hold them open is less than the critical closing pressure. As a consequence, blood flow through some of the capillaries may be eliminated with resultant reduction in the area of the active diffusing surface and reduction in the diffusing capacity as determined. Such a mechanism would account for the dynamic changes in the capillary bed which were postulated to explain the difference between the diffusing capacity at rest and during exercise. Footnote: These mechanisms would apply to normal as well as pathological states.

"The objection may be raised that the pulmonary vascular pressures are high in mitral stenosis and that, therefore, all vessels must necessarily be open even in the resting state. To this it could be answered that the pulmonary vascular resistance is also high in mitral stenosis, suggesting that the tone of the small vessels, and hence their critical closing pressure, is high. Probably the balance between the pressures tending to hold the vessels open and the vasomotor tone tending to close them determines which vessels remain patent and which do not.
“It may be postulated that gas exchange takes place across virtually all capillary walls during strenuous exercise, and that the diffusing capacity, determined under these conditions, is related to the structural characteristics of the entire diffusing surface of the lung. If this is so, the highest value obtainable during exercise, called the maximal diffusing capacity, may be interpreted in static morphologic terms. Values obtained at rest, on the other hand, are almost certainly affected by dynamic, as well as static, factors. It is therefore felt, that quantitative interpretations regarding the over-all structure of the diffusing surface are not justified by knowledge of the resting diffusing capacity alone.”

This latest expression of current views on the functional activity of the diffusing surface was quoted in full in order to emphasize the following significant points: 1) Current views involve as much speculation about the changes in question as does the concept of visceral lung function.

2) These views are based on a new concept of a capillary mechanism the application of which to pulmonary capillaries is more than questionable, for there is reason to believe that these capillaries are perhaps unique in the body.7

3) These observations indicate that the changes in diffusing surface by which diffusing capacity is increased normally occur even under such (pathologic) conditions in which it is most difficult to visualize increased capillary perfusion. It would seem that under the circumstances in question these observations are better explained by qualitative changes in the diffusion surface than by increase in capillary perfusion.

4) There are still other gas exchange phenomena which are difficult to explain on the view that functional changes of the diffusing surface can be only quantitative in nature. Perhaps the most important of these which has as yet received little consideration is the nature of the difference in individual diffusing capacity, i.e., the individually different diffusing constants. Why do some individuals accomplish the same amount of gas exchange with less circulatory and ventilatory effort than others even while at rest and particularly during exercise. To say the least these differences in diffusing capacity are not adequately explained by merely quantitative changes, they strongly point toward changes in the quality of the diffusing surface.

The above quotation of current views on the functional changes in the diffusing surface illustrate furthermore the prevailing trend to dismiss without any explanation, as unlikely, the possibility of qualitative changes in the diffusing surface. It is not even considered necessary to explain why it is unlikely that the functional changes in the alveolar membrane could involve variations in the diffusion characteristics such as to permit changes in the permeability to oxygen of the diffusing surface in accordance with the momentary needs of the body.

It should be noted that the occurrence of changes in the alveolar membrane which alter its permeability to oxygen have long been proved and accepted as the most important pathologic change in pulmonary diseases in which its diffusing capacity is decreased. It is a long recognized prin-
ciple that pathologic changes differ from the normal only in extent but not in kind. Why then is it held inconceivable that changes of the alveolar membrane in the opposite direction which would increase its permeability to oxygen could ever occur as a part of normal lung function? The reason for this is not apparent unless it is the strong trend to express all biological phenomena in strictly mechanistic terms. As Einstein has recently described this trend, "Physics ... has often seduced the biologist into interpreting biological phenomena too primitively."

If we accept the principle that functional changes in the structures of the breathing surface serve to adapt it to the momentary requirements for gas exchange, it becomes logical to assume simultaneous changes in quality as well as in quantity. This is precisely what is assumed in the concept of visceral lung function. Considerations already briefly mentioned before led the writer to stress the assumption that not only is the number of perfused capillaries, i.e., their area of exposure increased, but also that as these capillaries spring forward into the momentarily active air spaces the semi-fluid membranes of these is being thinned out so that the interface separating blood and air permits the most intimate contact between them. Thus the diffusing surface and its permeability to oxygen increase simultaneously.

There is reason to believe that variations in the proportion of qualitative to quantitative changes will probably account for individual differences in "diffusion constants." By the same token it will explain the great individual differences in the ability to increase diffusing capacity during exercise.

Present knowledge of the gas exchange process in the lungs we believe, justify the following two assumptions: (1) There exists a special functional activity of the breathing surface structures which serve to adapt the diffusing surface constantly to the momentary gas exchange requirements of the body. (2) This activity is of a type involving changes in quality (permeability) as well as in quantity (extent) of the diffusing surface.

**IV. Indications for a Hormone of Lung Function:**

The manner in which lung function is regulated according to the needs of the body and correlated with cardiocirculatory function under normal and under abnormal conditions gives ample indication of what is often referred to as the "wisdom of the body." This regulation and correlation of visceral functions is known to be mediated by the action of hormones specific for each of the participating organs. Visceral lung function is to be conceived as analogous to other visceral functions. Like renal and hepatic functions, lung function implies in addition to the visible and measurable phenomena (ventilation, circulation, gas exchange) some as yet unrevealed subtle functional mechanism the seat of which is in the structures of its ultimate organic units (capillaries and membranes of alveoli), the activity of which is under autonomic control mediated by a specific hormone acting locally upon chemoreceptor and pressor receptor elements. The presence of such receptors has recently been demonstrated in the ultimate lung structures.¹⁷
As in other organs, so in the lungs, hormonal action is most conspicuous in the regulation of its visceral circulation which is quite analogous to that of the liver and kidneys. All these organs have a common vascular hilum and intrinsic vascular nets arranged according to the same general plan. They have separate functional and nutritional blood supplies with anastomoses between these double vascular beds at several levels in the parts and in the units of the organs. The complexity of their vascular nets points to the purposeful functional independence of the organ units where local regulations under central control are mediated by hormonal action as manifestations of the “wisdom of the body.”

One manifestation of this has been demonstrated in the visceral circulation of the lungs which is so regulated that blood is constantly diverted to those organ units which at the moment can provide the most effective oxygenation. The mechanism implied in this function involves regulation of peripheral blood flow in the lungs correlated with the momentary levels of gas tensions in the blood of the capillaries and in the air of the alveoli. According to its need for gas exchange, blood is diverted to well ventilated and blocked in underventilated air spaces. The shunting of blood flow from unventilated lungs in so-called N-lung experiments and the remarkable extent to which blood flow has been shown to be diverted from unventilated lung areas even under pathologic conditions are all manifestations of the “wisdom of the body.”

Even more remarkably is this demonstrated in the blocking of the flow of fully oxygenated blood to the capillaries of the lungs. This is particularly manifest in congenital cardiac disease which would result in oxygenated blood passing to the lungs. The high pulmonary vascular resistance which develops here was described by Hamilton as “life-saving pathology,” for “if a normal peripheral resistance existed in both the systemic and pulmonary vascular body all of the ventricular output would pass out into the pulmonary artery and the pressure in the common ventricle would never rise enough to make blood go out of the aorta and supply the body.” While Hamilton referred especially to such congenital cardiac defects as Eisenmenger’s syndrome, Tetralogy of Fallot, this applies substantially to all patencies between the two sides of the heart permitting oxygenated blood to pass back to the lungs (left to right shunt). As a matter of fact there is evidence of this phenomenon in congenital cardiac disease with right to left shunts and in pulmonary conditions which involve by-passing of parts of the pulmonary circulation. The latter involve increased blood-flow from the collateral bronchial circulation which being fully oxygenated elicits the same vascular reaction in the pulmonary circulation. Recent observations have demonstrated that the passage of oxygenated blood in the capillaries adversely affects vascular function as indicated by its effect on the diffusing capacity of the lung area involved. The truly functional character of this phenomenon is indicated by its reversible nature. With interruption of the shunt, diffusing capacity returns to normal and upon reopening of the shunt it becomes abnormal again.

Hormonal action upon the capillaries is strongly suggested by observa-
tions made in clubbed fingers. It has been long known that clubbing of fingers develops in pulmonary diseases and in cardiac conditions affecting the pulmonary circulation. It was therefore repeatedly inferred that some substance produced in the affected parts of the lungs is responsible for the phenomena of clubbing. It has recently been demonstrated\textsuperscript{21} that clubbing involves structural changes due to altered circulation in the terminal capillaries of the digits. It is reasonable to assume that the stimulus for this altered capillary circulation is derived from the lungs where pathologic changes altering capillary circulation occur at the same time. Furthermore since we know that capillary flow in the periphery of the lungs is regulated locally and its control is mediated by hormonal action, it becomes quite reasonable to consider the possibility that this hormone—possessing specific effect on certain type of capillaries may, by passing from the lungs into the systemic circulation, produce under pathologic conditions clubbing at the body tips, where analogous terminal capillaries exist.

The discussion of the above listed aspects of pulmonary function does not pretend to be complete in any sense. Space does not permit here an exhaustive review of the subject. There are several other aspects of lung function in which much evidence can be gleaned in favor of a special visceral activity, the discussion of which must be left for another time and place. However at least very brief mention should be made here of two more fundamental aspects, namely, “self-cleansing” and “blood depot” function of the lungs. Here again old and recent observations have revealed facts difficult to explain on current views but actually implied in the assumption of visceral lung function.

In “self-cleansing” it has been a long standing problem how inhaled particulate matter reaches the interstitial tissues of the lungs without evidence of having been carried inward by cells lining the air spaces which are supposed to have ingested them.

“Blood depot” function was first postulated by the writer in a publication in 1929.\textsuperscript{22} Recent studies have confirmed the fact that the volume of blood normally contained by the lungs is far in excess of their momentary circulation.\textsuperscript{23} This raises the great problem not only of the disposition of this large reservoir of blood within the sections of the pulmonary capillary bed but also of its coordination with lung function proper.

In the publication repeatedly referred to above\textsuperscript{1} it was shown that the answer to both of these questions lies in the very nature of visceral lung function.

**SUMMARY**

The concept of visceral lung function was proposed by the writer nearly two decades ago. The problem is here reviewed in the light of some recent developments. The following aspects of lung function and dysfunction are considered.

1) Recent trends indicate that prevailing concepts of lung function are too mechanistic. They have led to the view that elastic recoil, comparable
with that of lifeless rubber, is the sole function of the organ. The need for a more biological concept is obvious.

2) In the establishment of lung function at birth and in the maintainance of the breathing surface throughout life the features of structure and function relationships may reasonably be interpreted as breathing surface creating activity. This is what the writer refers to as the visceral function of the lungs.

3) Recently revealed phenomena of the most purposeful correlation of ventilation and circulation throughout all parts of the lungs, and correlation of diffusing capacity with momentary requirements of the body in health and disease, are not adequately explained by present concepts. These unsolved problems of lung function and dysfunction point logically towards the possibility of an intrinsic function in the lungs, which affords reasonable solutions for these phenomena.

4) The existence of a specific hormone of lung function may be inferred from a number of long known facts and from some more recent observations, which also point to a true organ function of the lungs.

On the basis of the above considerations it is believed that the assumption of visceral lung function is justified at least as a working theory.

RESUMEN

El concepto de la función de los pulmones como órganos fue propuesto hace casi veinte años por el autor. El problema se reexamina aquí, dados ciertos acontecimientos nuevos. Son tratados los siguientes aspectos de la función y de la disfunción de los pulmones:

1) La dirección de las investigaciones recientes indica que los conceptos reinantes de la función de los pulmones son demasiado mecánicos. De ellos proviene la opinión que el rebozo elástico—comparable al caucho inanimado—es la única función de los pulmones. Se ve claramente la necesidad de un concepto más biológico.

2) El comienzo de la función de los pulmones al nacer consta de la creación de una superficie respirante. Durante la vida, se mantiene esta superficie respirante por la función de las estructuras de las unidades orgánicas fundamentales de los pulmones. Se consideran muchos fenómenos de la correspondencia entre su estructura y su función como ejemplos de la creación activa de una superficie respirante. Esto es lo que llama el autor la función orgánica de los pulmones.

3) Los conceptos reinantes no explican adecuadamente ciertos fenómenos, descubiertos recientemente, de la correlación muy a propósito por todas partes de los pulmones, de la ventilación y de la circulación. Asimismo no explican la correlación entre la capacidad de difusión y las exigencias del cuerpo, en el estado de enfermedad como en el de salud, de un momento a otro. Estos problemas no aclarados de la función y de la disfunción de los pulmones sugieren lógicamente la posibilidad de que haya una función intrínseca dentro de los pulmones, la cual explica estos fenómenos.

Se infiere de ciertos hechos, conocidos durante mucho tiempo, y de algunas observaciones más recientes, que hay una hormona específica rela-
cionada con la función de los pulmones. Estas observaciones también apuntan la verdadera función orgánica de los pulmones.

Dadas las consideraciones susodichas, el autor cree que se justifica la suposición de la función orgánica de los pulmones, por lo menos como teoría práctica.

**RESUME**

Le concept d'une fonction viscérale du poumon a déjà été proposé par l'auteur il y a près de 20 ans. Le problème est ici reconsidéré à la lumière de quelque developments récentes. Les aspects suivants de la fonction ou de la disfonction du poumon sont considérés.

1) Les tendances récentes indiquent que les concepts qui prevalett assignent au poumon un role trop mécanique. Elles ont amène le point de vue de la retraction elástique, comparable à celle de caoutchouc inerte, comme seule fonction de l'organe. La nécessité d'une concepte plus biologique est evidente.

2) L'establishement de la fonction du poumon a la naissance, implique le création du surface respiratoire. A travers tout la vie la surface respiratoire est maintenu par la fonction de structures dernières du poumon. Ici plusieurs phenomenes de relation entre la structure et la function prennent être raisonnablement interprétée comme activité de creation de surface respiratoire. C'est dans ce sens que l'auteur parle de fonction viscérale des poumons.

3) Les faits récemment revelâts de la plus intime correlation entre la ventilation et la circulation à travers toutes les parties du poumon, et la correlation de la capacité de diffusion gaseux selon les besoins momentanés du corps à l'état du santé et de maladie, ne sont pas pertinemment expliqué par les présents conceptes. Ces problèmes non resolus de la fonction du poumon indiquent logiquement qu'il faut rendre vers la possibilité d'une fonction intrinsèque des poumons, qui pourra rendre compte de ces phenomenes.

4) L'existence d'une hormone specifique de la fonction pulmonaire, peut être deduite par un nombre de faits connus depuis longtemps et par des observations plus récentes, qui marquent aussi l'existence d'une véritable fonction d'organe des poumons.

Sur la base des considerations precedents l'auteur sense que l'hypothèse d'une fonction viscérale du poumon est justifiée, ne serait-ce que comme hypothese d'étude.

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