

THE NUTRITIVE FUNCTION OF THE BRONCHIAL ARTERIES IN GROWTH. DISEASE AND REPAIR OF PULMONARY TISSUE.

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For a long time the important function of respiration has engaged the close study of physiologists, and the intricate exchange of gases in the pulmonic alveoli is beautifully if not accurately described. Here permit me to briefly but emphatically assert that the physiologic interchange of gases in the pulmonic tissues, by which this form of metabolism is maintained, is a process as directly under the control of vital forces as is that of the blood-current in its interminable circuit.¹ The dialytic laws of gases evolved in the laboratory should not be employed in the study of the interchange of gases in *vital* respiration.

The intervening basement membrane forming the cecum of the bronchial termini is a recognized histologic tissue continuous and impermeable unless excited to functionation by its proper vital stimulus.

The ciliated epithelia lining its mucous, and the endangial membrane lining its distal, side are on each side of this histologic division, elements capable of functioning to that high degree that they may select and transmit oxygen from the alveolar side, and from the endangial² emit detritic carbon dioxid by an alchemy which we must confess we can not demonstrate physically or explain literally, but that still exists as a potent *vital*, and not a *physical* process.

Of the origin and distribution of the bronchial arteries nothing new can be offered. "The bronchial arteries are the *nutrient* vessels of the lungs and vary in number, size and origin: that of the right side, from the first aortic intercostal, or by a common trunk with the left bronchial from the front of the thoracic aorta. Those of the left side, usually two in number, arise from the thoracic aorta, one a little lower than the other. Each vessel is directed to the back part of the corresponding bronchus, along which it runs," dividing and subdividing with a somewhat regular dichotomy upon the bronchial tube supplying them, the cellular tissue of the lungs, the bronchial glands and esophagus.³ The bronchial arteries in their distribution follow the pulmonary vein and artery as their vasa-vasorum, to the pulmonary artery, even to the one-twenty-fourth of an inch in diameter.⁴ Those supplying the bronchial tubes form a capillary plexus, first in the outer wall and muscular coat, from which branches are given off, to form a second plexus in the mucous coat; these capillaries form the densest plexus known in the human body;⁵ not excepting the pia of the cortex cerebri, and nowhere is inflammatory action so easily started as beneath or within the pleura, where lie these dense branches of the capillaries of the bronchial artery.

The diameters of the intercapillary spaces are often less than the diameter of the vessels themselves;² this plexus is separate from that formed by the pulmonary artery over the infundibula, and has a function in common with the capillaries of any area of the systemic circulatory apparatus, that of nutrition; some of its branches probably inosculate with the capillaries originating the pulmonary vein, carrying new oxygenated blood into and through the left cylinders into the current of the general or systemic nutritive circuit. Everywhere in its distribution through the pulmonary area

it has the common function of all the vessels of the systemic circuit and is as distinctively separate from affiliation with the pulmonary aerating circulation, as is that of the plantar or occipital area.⁶

The pulmonary artery—carrying venous blood and passing into and around the acini—has, prior to reaching this tissue, given up all its nutritive pabulum to the sustenance of the tissue it met in its rounds, prior to arriving at the power-house of the right heart, its metabolic forces having been totally exhausted; it might have its reticulæ multiplied many fold and yet it could not impart one iota of nutrition to impaired, injured or destroyed lung tissue.

It is the bronchial artery circulating in the intercellular spaces of the lungs, apart from the vessels involved in the pneumonic process, that prevents a sweeping destruction of the lung tissue when injured or diseased; the mucous membrane of the infundibula, in communication with tidal air, furnishes a favorable nidus for germ culture in which pneumococcus and influenza bacilli, for acute disease, and tubercle bacilli for chronic, grow in a culture-medium supplied by the functional capillaries of the lung.⁷

Not only is *nutrition* maintained through the bronchial artery, but the excess of pneumatic acid, necessary to the liberation of carbon dioxid from the functional circuit, is kept up by it, which laboratory experiments also have proved is fatal to the propagation of the pneumococcus especially, and probably to that of other toxic organisms.

Another recognition that should be given the bronchial artery is that the integrity of the entire pulmonary structure is maintained during intrauterine life by it; that the functional circuit is dormant until the emergence of the child into its newer existence; that the life of the parts, to their smallest histologic elements, is dependent on the distribution of this artery, nerves, lymphatics and intercellular fiber.

When atelectasis pulmonum takes place, either induced by pathologic or experimental methods, circulation for that area, whether a lobule, a lobe or a lung, there, for that time, can be no uses for the circuit of the pulmonary vein and pulmonary artery, and should the bronchial artery become occluded by a thrombus or a ligature, a destructive and locally fatal necrobiosis would soon be anticipated—a gangrene of the lung or, in a young subject, an atrophy.

The so-called obstruction in pneumonia, to respiration and circulation, with its attendant cyanosis and dyspnea due to the alleged exudative plugging of the bronchi and alveoli, must have some other explanation, as the impeded respiration and cyanosis disappear by lysis, while it is not possible that the exudate could be so suddenly removed; absorption of exudative matter, whether interstitial or pleuritic, can be affected only through the activity and release of the capillaries of the systemic circulation of which the bronchial artery forms a part.⁷

In the experiments in induced atelectasis, where an entire lung has been occluded either by ligature or compression, long periods can elapse before necroses ensue, so long as the bronchial artery or its branches remain patulous.⁸

The pulmonary pleura is dependent on the bronchial artery for its nutritive supply, though the functional circuit forms as dense a plexus on its proximal side as the bronchial artery on its distal; it is the anatomic and physiologic distribution and activity of the bronchial artery that makes possible the many evidences of repaired tuberculosis of the lung, cited by Osler of Baltimore,

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Bollinger of Munich, Boudet of Paris, Heitler of Vienna, Flint of New York, and Fowler of London, with numerous other observers who can confirm their observations.⁹ This is a fact which should have great publicity, to both awaken and quicken hope and dispel the pall which falls over one in whom an early but kindly diagnosis has been made for self and friends; for with no malady is the error more prevalent than with pulmonary tuberculosis, that it is incurable, whereas the contrary prevails.

Phthisio-therapeusis is to-day held in a thralldom of ignorance and superstition, by the physician and the layman, that is deplorable in the present light of collateral knowledge.

The study of the physiology and chemistry of respiration is overlooked in the eager search for a specific for the unwelcome plague that blights so many homes. The avidity with which every phantom is reached after that is projected into the darkness, attests this truth; and we need not look backward very far to the time when Weigert's hot-air inspiration was a fad; or when Bergeron's bombardment with sulphuretted hydrogen was urged in homes and hospitals, but is now a discarded and disowned outcast by parent and employer; respirators, inhalers and exhalers have burdened the patent office and glutted a hungry market; costly cabinets have been built and leased to regulate intrathoracic pressure, when it has been a long known physiologic truth that the proportion of oxygen in the blood can not be increased by pressure, nor is it diminished by reduction of the pressure until it approaches a vacuum." When inanition has proceeded so far that muscular dynamism is no longer co-ordinated to functionate normal respiration, involuntary or voluntary, then mechanical resuscitation in broken-down or diseased pulmonary tissue would be indeed futile if not absolutely injurious.

Public-school text-books do not teach, and medical teachers and students do not study, the anatomic aids or physiologic processes of normal respiration enough. Solid and liquid foods and culinary arts are studied until cooking is regarded as an index of civilization. The therapeutic market is congested with digestive aids, until physicians and laymen are confused as to what to choose, whose or which chemical aid they shall invoke to conduct or complete a low, plain, simple, organic process, when innocence and abstinence alone should indicate the remedy; while, the first food we grasp for quality or quantity at our advent here, and the last we sigh for before we go hence, the "breath of life," and its uses, we utterly ignore.

Every physician accustomed to auscultation too often recognizes, especially in women, the inadequate function of respiration; another class, in whose members the same defect is observed, comprises the indifferent workman and tobacco habitués; still another is that easy-going, quasi-sporting element, including the gourmand, whose whole thought is to that zone below the diaphragm, whose choked liver and kidneys soon mark their habit and chrome their skin.

I once had an opportunity to auscultate a healthy chief of the Cheyennes, on the plains of Montana, and while breathing freedom's air from childhood, his lungs hung like a flabby appendix in his massive thorax, and I knew that the traditional "wind" of the Indian was a myth, and the "white plague" would soon wipe out his race.

A comparison of the post-mortem evidences of repair of tuberculosis of the various tissues of the human body shows that the lung far exceeds any other tissue in the body—not excepting the peritoneum—in its ability to overcome the effects of tubercular inoculation.

This, it must be admitted, is largely due to the systemic circuit of the obscure bronchial artery and its nutritional activity; while it also urges that a due anatomic and physiologic recognition of this artery, as belonging to the systemic and nutritional system as distinct from the purely functional one of the pneumonic system, will tend to introduce study for strengthening healthy, and repairing diseased, lung tissue through the proper channels, instead of clinging to the popular though erroneous methods of projecting or aspirating medicaments into and upon the mucous surface, that we know must stop at their first impact; the vibrillary motion of the cilia lining the bronchi, which is constantly toward the point of entrance, must prevent them, either by gravity or current, from ever reaching their intended, traumatic or diseased destination, whether these medicaments be sprays, nebulae or gases.

Nutrition and repair of impaired pulmonary tissue must be carried on through channels, identical with other similar processes, in other structures; and this, it is recognized, must be done through the metabolic functions of the systemic blood-current, by the selective affinity or specific action of tissue,¹² each fiber for its part, and in this the bronchial artery is the only source of nutrition for pulmonary histologic elements, and the pulmonary veins and pulmonary artery have no function for this.¹³

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SOME POINTS IN TREATMENT OF SEVERE CRUSH INJURIES OF THE EXTREMITIES*.

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In almost twenty years of observation, but more especially as attending surgeon to a large general hospital, which experience has been supplemented by a considerable experience in railroad injuries also, the writer has been particularly impressed with the urgent need of a better knowledge and comprehension, by the general profession, the general surgeon, and even the railroad surgeon, of the character of severe crush injuries of the extremities, the prerequisite to the proper insight to treatment. It has been a too frequent experience to witness the loss of limbs, and even loss of lives, from surgical treatment so much worse than useless as to be pernicious, and which displayed an amount of ignorance on the part of the practitioner which might be considered criminal, were the efforts not clothed with good intentions. It has been a too frequent observation that surgeons seemed to lack a proper knowledge of the surgical principles involved, and also that even railroad surgeons fall short of the best results.

The general practitioner fails from a lack of the application of surgical principles, contained in all our text-

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