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IN SUDDEN DEATH;

TOGETHER WITH A PLEA FOR CARDIAC ASPIRATION.

BY

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FROM

THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES,
JANUARY, 1885.



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of the Brooklyn Pathological Society, etc.¹

THE two objects in writing this note are indicated in the title, *i. e.*, first, to draw attention to a peculiar form of pulmonary congestion that is not generally known nor properly understood, and which ends in sudden death; second, to enter a plea in defence of the operation of aspiration of the right heart, as originally proposed by Dr. B. F. Westbrook, of Brooklyn, N. Y., and performed by him in one case.

Facilities that I may presume to call unusual are afforded me every year in the study of the pathology of several hundred cases of sudden death. During the last two years, I have frequently met with cases of the kind I will describe more fully below. I have recorded, as well as I can now remember, a little more than one-half of those seen. My recorded cases number more than thirty, to which may be added three more made within two days of the present writing. Very seldom has it happened that I have been called upon to make an autopsy in these cases during the warm months. They occur most frequently in spring and fall, many also being encountered throughout the winter. The great majority, however, are met with in the course of the temperate seasons, when the weather is prone to change rapidly and in a marked degree.

In all of these cases, both lungs were affected, and to the same extent with only a few exceptions. Whenever a difference between the two sides existed, it was only slight. With rare exceptions, the lungs were uni-

¹ Read before the Medical Society of Northampton Co., at Bath, Northampton Co., Pa., 1884.

formly affected, there being no patchy appearance on section and no evidence of either ante-mortem or post-mortem gravitation of blood. The narrow apex or sharp anterior margin was as full of blood as the rounded posterior border or the broad base resting upon the diaphragm. In those few cases in which the congestion was not uniform, but presented a patchy appearance, the lighter spots were no more numerous nor was their location better marked in the dependent parts of the lung than in other portions. Thus a light congestive patch would be found adjoining a coal black field of lung tissue at the sharp free anterior margin.

Similar conditions would be noticed throughout the same organ without reference to the laws of gravitation. When the congestion is uniform, the lung appears, on section, as black as ink, and slight pressure causes an exudation of thick and perfectly black blood. Very often there also exists considerable œdema, and this, also frequently, without depending on hypostasis, for it may be noticed in the uppermost parts of the organ, while hardly any is seen in the more dependent portions. Crepitation is, as a rule, present in all parts of the lungs, and where it is absent a condition of collapse is noted. Occasionally, of course, there are found solid tubercular and other deposits as in any other lung.

A remarkable peculiarity in this connection is the frequent absence in the middle lobe of the right lung of any great degree of congestion. This is most often seen in cases of pneumonitis. Many a case of double pneumonitis, or others where the upper and lower lobes of the right lung were involved, the left lung not being affected, has shown the middle lobe to be perfectly normal.

The pleuræ generally have a dark purplish-red color, mottled here and there with irregular bluish spots. It will sometimes happen that the external coloration of the lungs does not convey any adequate idea as to the intensity of the engorgement within. It is by no means infrequent that the necroscopist is surprised beyond measure at the intensity of the passive engorgement of the lung, after having suspected but a slight congestion from the light appearance of the outer surface.

The appearance of the heart and great vessels is hardly second to the condition of the lungs. I have invariably found the right side enormously distended and the *ostium venosum* entirely incompetent, with its tricuspid valve, to stem the return flow from the right ventricle, thus practically throwing the right auricle and ventricle into one large auriculo-ventricular cavity. In fact, I have this day encountered a heart so dilated, in the case of an habitual drunkard, as to admit of the introduction of my whole hand, previously folded as small as possible, beyond the metacarpo-phalangeal articulations. The circumference of the right auriculo-ventricular orifice must, therefore, have been at least 18 centimetres, as the smallest measurement around my contracted hand is over 20 centimetres. This is

the largest *ostium venosum* that I have ever seen in these cases. In most of the cases this opening easily admitted my four fingers and thumb as far as the middle of the proximal phalanges, *i. e.*, was about 13 centimetres in average circumference. The normal average is 10 centimetres, according to Quain readily admitting three fingers, but as fingers differ in size, this is not a very accurate test. I have also found the pulmonary artery distended with dark blood in all cases. Its orifice, as a rule, permits of the easy entrance of three fingers in these instances, *i. e.*, is about 10 centimetres in circumference. The one in the above-mentioned case of the large *ostium venosum* was fully 13 centimetres in circumference. In these cases, the pulmonary valves are always incompetent, and hence readily admit considerable regurgitation. The left heart is invariably either empty or contains but a very small quantity of blood. The pulmonary veins are also empty, or very nearly so. I have always found the whole heart relaxed. Not more than three or four of all the cases in this class that have come under my observation during the last two years presented any valvular disease.

The conditions of other organs varied greatly. The liver is usually either healthy, fatty, or in the active or passive state of chronic interstitial inflammation. The spleen may be normal or show an increase of its connective tissue. The kidneys are often either in the active or passive state of interstitial inflammation.

The principal feature in connection with the abdominal organs is their degree of sanguination. In the bodies of persons who are poorly nourished and evidently more or less anæmic, the abdominal organs are in a condition of marked exsanguination, while, on the other hand, they are gorged with very dark blood in the well nourished and plethoric. Any variety of sanguination of these organs is noticed between these two extreme conditions of the individual. The peripheral veins, however, are in all cases empty and collapsed, and in anæmic cases, even the *vena porta* and its tributaries are almost entirely devoid of blood. The capillaries are not as full as usual except in the face and neck, where they contain well carbonized blood. The cerebral veins usually contain more or less very dark blood in those who have enjoyed average health or were plethoric, but, otherwise, they are also as devoid of their usual contents as are the other veins.

Etiological data are very important factors in the treatment of disease, and therefore the consideration of the causes of these fatal congestions, though largely speculative, is fully within the boundaries of perfect propriety.

First, I have noticed that a great proportion of these fatal congestions occur in persons more or less inclined to *drunkenness*, but it is by no means limited to this class. Again and again has it occurred that some of these unfortunate beings returned home intoxicated and laid down to

sleep, never to awaken. Not only do they die in their beds, but upon the floors of their rooms, in halls, streets, gutters, in boxes, station and lodging houses, upon trucks, and in short, wherever a drunken person is apt to go for rest. Secondly, that *cold* is an important factor is self-evident. It, however, is hardly a sufficient cause for these phenomena, as it often happens that the person having succumbed to one of these fatal congestions, of which I speak, has been previously afflicted with an ordinary congestion many a time, and without a bad result. Third, *exposure and privation* seem to exert as potent an influence in the production of this malady as does drunkenness. Yet, I have often seen typical cases of fatal congestion in persons having comfortable, nay, even luxurious homes, and who were total abstainers from alcoholic or malt beverages.

What, then, is the underlying cause of this affection, which can rationally be supposed to exist in all of the cases that I have seen? To my mind it seems clear that the *sine qua non* in its production is essentially a nervous influence; or, perhaps, more truly still, the absence of the normal nervous control of the pulmonary circulation. Whether this be an affection of the respiratory centre, perhaps in a state of constant irritation, exerting an inhibitory influence over the pulmonary sympathetic, or a depressed state of that section of the sympathetic which controls the pulmonary circulation, or whether it may be both, I have not sufficiently good data to enable me to rationally claim. It is, however, my opinion that this congestion is at first a blush of the lungs, occurring in the same manner as a blush of the cheek, *i. e.*, by a sudden dilatation of the capillaries, due either to an inhibitory influence of the cerebro-spinal axis, or a depression of the pulmonary sympathetic. It may be fair to assume, in the uncertain state of our knowledge upon this question, that both influences exist at the beginning; and that, while the cerebro-spinal axis returns to its normal state, the pulmonary sympathetic is permanently paralyzed, and thus the blood stagnates in the capillaries of the lungs, in consequence of the inertness of its environing channels. That in such a condition the alternate contraction and dilatation of the left auricle and ventricle, together with the aspiratory function of the thorax, would not be sufficient to prevent the stagnation of blood in the lungs, seems assured upon *a priori* reasoning, on account of the physical obstacles (as friction) encountered in the exceeding minuteness and enormous multiplicity of the tubular network through which the circulation takes place. This *a priori* reasoning is proven to be true on the autopsy table in every one of these cases. Almost all the blood is found pent up in the *venæ cavae*, right heart, pulmonary artery, and lungs. The pulmonary veins, left heart, arteries, systemic capillaries, and peripheral veins, are either entirely or almost devoid of their usual contents. In very full-blooded persons the venous engorgement extends back into the liver, spleen, and kidneys, and sometimes to the brain. In no other conditions, that I have ever seen,

do these three abdominal organs together appear so full of black blood. In no case, no matter how full-blooded, did the venous engorgement extend beyond the cavities of the trunk and cranium.

I will here incidentally mention that, as the first stage of pneumonitis is different from an ordinary congestion of the lungs, and as these fatal congestions of which I write also differ essentially from ordinary pulmonary hyperamiae, and as these fatal congestions or engorgements are very similar in appearance to the first stage of pneumonitis, the hypothesis of a nervous influence as a cause in the one is equally probable as the essential factor in the production of the other.

At first there is but slight disturbance of the equilibrium between the pulmonary and systemic circulations. Steadily, but surely, this disproportion between the two sides increases. The arterial side of the circulation is losing its blood constantly in greater amount than it is supplied from the lung by the pulmonary veins. In time the lungs become surcharged with blood. The air-chambers are diminished in size, on account of the tumefaction of the interstitial structures of the lung, by the enormous dilatation of the gorged capillaries. Hence less air enters, and the blood becomes extremely carbonized and deoxidized. All the cells of the body therefore suffer more or less true asphyxia; nor is this all, they are robbed of a share of their usual nourishment. What blood does pass to the left heart, then, is very poor in oxygen. When the lungs are saturated with blood the right heart begins to experience the pressure of the blood that is being pumped on by the poorly oxidized left ventricle, the arteries, and the capillaries. Soon the pressure becomes too much. The openings of the right ventricle begin to dilate, and their valves become incompetent to check the return flow of the current. The right ventricle forces some of its contents into the pulmonary artery and lungs, to have a share of it regurgitated a moment after. In the same way the right auricle works with only partial success; for, in consequence of the dilatation of the *ostium venosum*, the tricuspid valve is ineffectual in preventing the back-flow of blood. While, at first, the amount of regurgitation is small, it gradually increases so as to amount to more than that which enters the lungs, and eventually hardly any passes to its normal destination, and nearly all the blood simply moves up and down in a continuous column, extending from the division of the pulmonary artery through the right ventricle and auricle into the upper and lower *venæ cavæ*. That the patient should be able to survive long with a heart in this condition is an impossibility. His exhausted heart yields in despair in a brief period unless prompt relief is afforded. Medicinal remedies are of exceedingly doubtful utility, for the very means (the circulation) by which we carry them to the parts to be affected are incompetent. Mechanical relief, therefore, is most urgently called for, but more of this later on.

The *symptomatology* of this affection is very meagre, as far as I have been able to determine in a study of the cases of which I speak. The duration is very short, probably never exceeding twenty to forty-eight hours from onset to termination; but I am inclined to fix the usual time at about six or eight hours. It occurs much oftener in males than in females, and I have never observed it in children.¹ There is frequently a sense of impending danger. In one of these cases that I have recorded I could get no further history than that the patient was a little quiet, and said to his wife, "I'm afraid I'm going to die, Annie." This impending sense is absent, however, in many cases, as far as could be ascertained. There may or may not be either unilateral or bilateral pain. An almost invariable symptom, if any at all are noted, is oppressed respiration. Thus one of my earliest cases was that of a young butcher, of average height and splendid muscular development. It had been a comparatively mild day in autumn and he had carelessly exposed himself to the sudden fall of temperature occurring during the latter part of the afternoon. When he arrived home in the evening, about 9 o'clock, he first began to feel uncomfortable. He said that he felt chilled to the bone, and could not get warm; that breathing was rather difficult and *unsatisfactory*; and repeatedly, in the midst of joyful surroundings, expressed the conviction that he might never leave his bed alive after having entered it that night. A strong mustard plaster was applied to his chest by one of his relatives, and his feet were bathed in hot mustard-water. Then he went to bed. In the morning his body was lifeless and cold, the latter fact proving that he must have been dead for some hours. He went to bed after 11 P. M., and his room was entered before 5 o'clock the next morning. Thus he must have died within two, or at most three, hours after retiring. The autopsy was made about fourteen hours after death. He had the blackest lungs I have ever seen, for they looked like tar. His left heart and arteries, as well as the pulmonary veins, were empty, while the right heart was enormously distended with black blood, as were also the pulmonary artery and the *vena cava*. His liver, spleen, and kidneys were in a state of the most intense venous congestion. The *vena porta* contained a little blood. The cerebral veins were almost empty. All the peripheral veins were collapsed and bloodless. And this state of affairs prevailed in a very full-blooded young man. The spinal cord was examined, but presented nothing abnormal.

A feeling of weariness is also occasionally complained of.

While dying, the face and neck very slowly become livid, but not as much so as in death from asphyxia. Death, when it has been observed by intelligent lay persons, was said to have occurred without a struggle, and in a moment.

¹ The case of a child I saw a short time ago seems to have been one of this class. It was but a few weeks of age, and had been poorly fed and exposed to the weather.

In one case, a tall, stout, and full-blooded young man, twenty-eight years of age, was chatting with his family. Talking became more and more difficult, until it was considered advisable to send for a physician, but this was postponed. The symptoms increased in severity till continuous talking became very difficult, when he suddenly reeled off his chair with a look of fear and perplexity, and was dead. His brain was examined and found normal, and the only signs to account for the sudden loss of life were discovered in the heart and lungs, which presented the appearances described in the preceding cases.

The symptoms, then, are briefly all those of a severe cold, minus the cough, although that is also present at times. The most marked symptoms, very often, are the oppression of breathing and the sense of impending death. Upon the dead body, percussion discovers marked dulness over all parts of the chest, and as all parts of the lung crepitate in most of these cases, a diminished respiratory sound, associated with moist rales, would most likely be announced by *ante-mortem* auscultation.

The *treatment* of this affection should be *prompt, decisive, and radical*. It is not fair to the patient to attempt the use of doubtful means. If any measure is already at hand which promises relief as soon as applied, that is the one to be used. Should no such remedy exist, it is perfectly just to devise some *radical* plan, which, if pursued, will *most likely* eventuate in the recovery of the threatened sufferer. Just the means that are here indicated have been devised and practised by my friend, Dr. Benjamin F. Westbrook, of Brooklyn, N. Y., *i. e.*, the operation of cardicentesis, or aspiration of the heart.¹ Even this remedial measure, prompt as it acts, must be quickly applied. No time is to be lost, as every minute may count.

I have detailed one case in which strong counter-irritation had been applied to the thoracic walls and the feet without avail. This is by no means the only one on my list. Others have been similarly treated, previous to death, with the like result. The immediate danger is not from asphyxia, but from heart failure, due to over-distension of the right side, and gross incompetence of the valves guarding the two orifices of the right ventricle. Relief, and the promptest kind too, must be tendered this organ, in preference to any other. Thus, there can be no doubt of the utility of the abstraction of enough blood from the right heart to allow it to regain its normal functional activity.

As is the fate of all innovations, however, whether good or bad, so it was that of Dr. Westbrook's operation to meet with opposition, and that of a decided character. It is also damaging to the interests of our profession that original thought should be opposed by iconoclastic criticism,

¹ See paper by Dr. Benjamin F. Westbrook, entitled "On Abstraction of Blood from the Right Heart, as a means of relieving intense Pulmonary Congestions," in the *Medical Record* of December 23, 1882.

as too frequently happens, and has occurred in connection with the operation of cardiacentesis. Let me beg of all critics to maintain that imperturbability of true impartial scientific criticism, and I will aver that their opinions will receive more respectful attention from those for whom they are meant than would result from any other course.

With reference to a rather harsh editorial appearing in the *Medical News* of February 3, 1883, I will say but a few words: First, to the question as to what it matters if the great venous trunks are perforated, there are two answers: one, that it matters *not*; the other, even if it did, they could never be perforated except by a careless or bungling operator. There is much less chance of touching the venous trunks in this operation than there is of cutting the brachial artery or median or musculo-cutaneous nerves in phlebotomy anterior to the elbow-joint. Second, it is *not true* that "when a needle is inserted the movements of the heart must widen the orifice made." *A priori* reasoning would, in the first place, refute this on account of the elasticity of the auricular walls and their fluid contents. This is proved *de facto*, as no mark could be found upon any part of the auricle operated upon by Dr. Westbrook to indicate the point of entrance of the needle.

Two writers in the *Medical Record* of January 20, 1883, Dr. Hal. C. Wyman, of Detroit, Mich., and Dr. Wm. T. Cheesman, of Auburn, N. Y., file their opinion against the operation of cardiacentesis. The former, however, tends to become sarcastic and jocose toward the end of his letter. It is hard to conceive how the cardiac valve might ever be "stitched up," but that divulsion of the cardiac orifices is much more plausible can readily be seen. I have long ago deemed divulsion of these openings a practicable operative procedure, and should not hesitate to have it done upon myself in case of stenosis of one of my own cardiac orifices. Lack of thorough anatomical knowledge makes even bold surgeons timid at times, and this is a fact that was fully appreciated by Prof. Billroth, when he exhorted his students to thoroughly master anatomy.¹

Dr. Cheesman asks if it is not an unhappy result to have even the slightest hæmo-pericardium follow the operation of aspirating the right auricle? I say *no*. If it is not success to save human life, although at the expense of even considerable outpouring of blood into the pericardium, rather than keep the pericardium clear at the expense of the patient's life, then no operation is successful. We cut off both lower extremities to save life, and if this object is attained, we speak of it as a successful operation. If we save life by cardiac aspiration, though at the expense of effusing an ounce of blood into the pericardium, it is a complete success, for the blood is easily absorbed, while we promptly deliver a human being from immi-

¹ "Anatomy, gentlemen! Anatomy, and again Anatomy! A human life often hangs on the certainty of your knowledge in this branch."

ment death, and leave him as well as he was before his trouble set in. How different is this from keeping him here minus two lower limbs. And yet the former should be a failure and the latter a success! He further says: "Bearing in mind the tenuity of the auricular wall, and the danger that it shall tear itself by motion against the needle (not a fanciful danger by any means), can we consider its puncture any other than a most hazardous expedient?" It is true that the auricular wall is tenuous, but it must also be borne in mind that it is elastic and contractile. No better practical demonstration could be asked for by the most exacting than resulted in the *post-mortem* examination of Dr. Westbrook's case. As was said once before, it was impossible to find any sign upon the wall of the auricle that might indicate the place of entrance of his needle. The doctor also states that he has known cardicentesis to have been resorted to in cases of immediate danger from heart failure, but he does not tell us how often, by whom, where, or when, nor with what success. Will he please publish an account of the cases he knows of, for they might prove valuable? His questions will be answered later on.

Dr. C. L. Dana reports two cases of cardicentesis in the *Medical Record* of February 3, 1883. In both, aspiration was practised after somatic death, but probably previous to complete cellular death. Half an ounce of blood was withdrawn from the first case without any effect. That is a result that I should have anticipated, and would doubt the success of the operation of restoring life if even several ounces had been abstracted, unless death had resulted primarily from heart failure, and even then other means would have to be resorted to for the purpose of starting the circulation. The operation was designed for the relief of the heart laboring under physical difficulties, and especially without organic lesions, and not to awaken its vitality once it had ceased to beat. In one case the puncture made by the needle in entering the heart was distinctly seen at the autopsy. It is proper to bear in mind, though, that the operation was performed upon the dead body. The first case cannot count on either side of this question, but is valuable in showing that the advantages of this operation had been previously appreciated to a certain extent. In the second case, the heart continued in action some time after respiration had stopped. He does not say whether he abstracted blood from the right ventricle while the heart was in action or after. So this case, too, as it now stands, is of no value in settling the doubt in the minds of those who would like to see more proof either way.¹

¹ On page 820 of the March number of the *Edinburgh Medical Journal* for this year, is a brief account, by a gentleman signing himself "An Asylum Assistant," of a case of probable transfusion of the lower part of the heart with a three and a half inch needle, or shawl-pin, for suicidal purposes. The symptoms were apparently alarming, but subsided upon the withdrawal of the offending body to reappear for a short time in several hours; after this complete recovery followed. The reporter of this

The value of cardicentesis over venesection consists in its being *simpler* and requiring paraphernalia less disheartening to the patient, being more prompt in its effect, necessitating less loss of blood, and that its performance is always possible, while in some cases the abstraction of sufficient blood by phlebotomy is not only impossible, but sure to hasten death. Simplicity is always desirable, and what can be a more simple operative procedure than the thrusting of a needle into the chest, especially as it causes no more inconvenience than the much-used, valuable hypodermic syringe?

Promptness is a great desideratum in all operations, whether the patient is under the influence of an anæsthetic or not, and this is particularly the case in instances in which the heart threatens to give out at any moment on account of physical impediments. If to this item of promptness the fact can be annexed that in this operation the same effect can be produced by the loss of less blood than is the case in phlebotomy under similar circumstances, another point in its favor is gained, and such is actually the fact.

There is one more point in favor of cardicentesis, and it is a weighty one. It is the fact that this operation is always possible and effectual, while phlebotomy is not, Dr. C. L. Dana to the contrary notwithstanding, for he says: "In cases of laboring heart I should vastly prefer venesection, whose potency is unquestionable."

It is certainly true, as has been remarked to me, that if one end of a tube is placed in a volume of water, while suction is made at the other extremity with the mouth, water will flow through the tube till suction is arrested. Furthermore, it will keep on flowing if the end of the tube to which suction has been applied be placed lower than the level of the volume of water from which that is derived which passes through the tube. This is on the principle of the siphon. Both may be combined with increased effect. This proposition has been presented in favor of phlebotomy as against cardicentesis. But the pulmonary circulation is not conducted on the principle of the siphon, so this must be eliminated. The blood is propelled from the right heart through the lungs to the left heart by several forces. The *vis a tergo* of the columns of blood in the systemic venous trunks pushed along by the systemic capillaries; the alternate contractions and relaxations of the veins from compressions due to flexions and extensions caused by muscular action; the effect of muscular con-

case considered the patient to have had a narrow escape, and no doubt she had, but it is inexplicable to me how he justified his opinion in viewing this case as proving the operation of "cardicentesis out of the range of practical surgery," for the very fact of her rapid and complete recovery following almost immediately upon the extraction of the needle goes to show that whatever danger there may be (and I doubt that there is any at all), is obviated by the removal of the cause which excites it. I cannot help viewing this gentleman's case as one to prove cardicentesis practicable, and it seems to me that so will be upon further deliberation.

tractions on the blood within the muscles and between them; and the contractions of the veins themselves, though slight; all these tend to push the blood forward to the right heart. The other forces, consisting in the comparatively passive dilatation of the left heart in response to the blood pressure from behind, which is caused by the compression of the lungs and their contained bloodvessels in expiration; and the capillary attraction and contraction itself are the ones that send the current to the left heart.

The dilatation of the left heart is not a *vis a fronte*, as is so often stated. Were radiating fibres attached to the ventricular walls so as to draw them out, and tend thus to create a vacuum in the general left auriculo-ventricular cavity, it would necessarily be an active force, drawing the blood into these cavities as a so-called suction-pump "draws" water. This, however, is not so, for the left heart dilates only passively in obedience to the inpouring of blood from the lungs.

The aspiratory function of the thorax also does not act as a propelling force to the arterial side of the lesser circulation. Whatever blood it does "suck" into the thoracic cavity is by way of the ascending and descending *venæ cavæ*. It tends to draw both air and blood into the lungs, but only succeeds in attracting that blood which comes from the peripheral venous system to the right heart and lungs, while on the other hand, it *retards* the circulation through the pulmonary veins *from* the lungs, for to these latter organs all the blood now tends that can go that way.¹ There is no impediment in its course on the venous side from the furthestmost systemic capillaries, while on the arterial side there is a very effectual barrier to any back flow not far from the lungs, consisting in the bicuspid valve. The aspiratory function of the thorax can, therefore, have no effect in filling the left heart, because the bicuspid valve effectually prevents aspiratory attraction of the arterial column beyond it by inspiration. During inspiration the blood tends *to* the lungs, as well as the air, from all possible directions. Its effect is most positively felt by that column of blood naturally coursing towards these organs, *i. e.*, the pulmo-systemic venous column. The valves in the veins, the tricuspid, and the pulmonary open toward the heart and lungs, and therefore offer no obstruction to the increased flow in this direction. The opposite prevails, though, in the other (arterial) column. Here the attraction is contrary to the current, which tends from the lungs. The bicuspid and aortic valves open

¹ The aspiratory effect of inspiration upon the heart has been fully considered, but not incorporated in the body of the paper, because the aspiratory effect upon the lungs preponderates over that exercised upon the left ventricle, which is opposed to them. In inspiration, the lungs tend to attract blood from the pulmonary veins and left auricle, while the left auricle and ventricle oppose it. The effect is a flowing of the current in this direction during inspiration. This mechanism seems so simple that I think it unnecessary to enter into further details, as it must be evident to all upon slight consideration.

from the lungs and close to prevent regurgitation to the organs whence the current came. Thus, during inspiration, the venous flow is accelerated and the arterial retarded. In expiration it is contrariwise. Here the lungs and thoracic parietes contract, causing a tendency to *expel* air and blood in all possible directions. The blood current now is *from* the lungs. It is contrary to the venous column and against the pulmonary and tricuspid valves and the valves of the veins, which prevent regurgitation during the diastole and period of cardiac rest when expiration is in progress. The direction of the current, though, is now *with* the arterial column, and *its* flow is *accelerated* through the pulmonary veins and left heart, the bicuspid and aortic valves now offering no resistance.

As is well known, the heart beats about four times during one respiratory act. Inspiration is active and a little longer than expiration, which is passive. The former aids the venous column which passes through the vessels that are larger, thinner, weaker, and less elastic than the arteries, and through the weaker side of the heart; the latter assists in propelling the blood along the left heart and arteries, which are in themselves much better adapted to carry on the circulation than the veins and right heart. The lungs, therefore, give more aid to the venous and weaker circulation than they do to the stronger arterial. The pulmonary circulation then may be viewed as follows: The right heart pumps blood into the pulmonary artery and its branches until they are well distended; inspiration takes place and draws the blood from the pulmonary artery into the pulmonary capillaries and at the same time attracts the blood from the large venous trunks into and close up to the right heart; expiration then forces the blood from the capillaries through the pulmonary veins into the left heart. These three steps might be designated in their order as first, that of *venous distension*; second, that of *capillary distension*; third, that of *arterial distension*. The circulation thus passes through the lungs in a series of three stages during every respiration.¹

Thus there is normally every provision for a perfect and ever moving circulation through the respiratory organs. No better arrangement could have been invented by a skilled engineer to prevent any improper working of this mechanism. The nervous systems control the contractile power of the pulmonary vessels and thus exert the same influence upon the circulating fluid passing through the lungs that the brakeman on a railway car exercises on the speed of the train by the judicious manipulation of his brake. Should, now, this lesser or pulmonary circulation become deranged at any time, it is very evident that one or more of the forces controlling it must have been primarily at fault. It must, therefore, exist

¹ It is a well-established fact, to my mind, that the perfection of the pulmonary circulation depends upon the character of the respiration. I have many a time verified by *post-mortem* examination the fact that the lungs are in a state of passive congestion just in proportion to their defective *ante-mortem* respiratory activity.

either in the right heart, the lungs, or the left heart. In all these cases that I have considered, and for the alleviation of which Dr. B. F. West-brook devised his operation, the fault did not lie in the right heart primarily, nor did it exist in the left heart; necessarily then, this first fault existed in the lungs. To determine what the exact cause was here, is rather difficult, but let us see.

Respiration is not modified in these cases except very late in the disease and then only as a consequence of the deranged state of the pulmonary circulation. The contractility of the capillaries and smaller vessels in the lungs is the only factor in the maintenance of the pulmonary circulation left us that may be at fault. This we cannot exclude, and it is the only one that it is impossible to cast aside. That those little vessels should have taken it upon themselves to suddenly and in concert refuse to contract as was their usual habit, is not a rational inference. Some higher power must have directed them, and this power is beyond a doubt located in either the medulla, or the pulmonary sympathetic, or both. The brake-man is at fault. The fact, however, remains the same, *i. e.*, that the original trouble was pulmonary and very likely began in the nervous system, and if the arterial side of the circulation was not able to *prevent* this difficulty, it certainly is powerless to *check* it afterward. This becomes still more evident when it is recollected that the arterial side of the circulation is gradually diminishing in vigor by slowly, but steadily and surely, losing its blood, and that blood is over-crowding the intra-thoracic venous system. Eventually the peripheral veins become empty and nearly all the blood has retreated to the lungs, the right heart, and its two great feeders.

While it is universally conceded that the abstraction of blood is in these cases the best remedy, the general impression is that simple venesection at the elbow is efficient and safe, while cardicentesis is dangerous and inadmissible. Let it be remembered, though, that the peripheral veins are almost entirely devoid of blood. The only direction from which blood can be drawn is from the arterial side through the capillaries, for the veins have valves, and being almost entirely empty no blood can be obtained from the right heart and lungs except in the most roundabout manner, *i. e.*, through the systemic venules, capillaries, arterioles, and arteries, the left heart and pulmonary veins, capillaries and artery. Should arteriotomy be attempted as a more direct means of getting the blood from that side of the circulation, as it must come from there anyway if cardicentesis is not performed, the end of the patient would only be hastened by depletion of the arteries in a shorter time than nature is doing it herself. For as the heart has not aspiratory power, the loss will not be made up by sufficient outpouring of blood from the lungs through the pulmonary veins in response to the sudden depletion of the vessels. By going to the auricle, though, we get ahead of the valves in the veins,

go at once to the seat of the trouble, abstract blood directly from the parts overloaded with it, and give immediate relief without depleting the arteries.

Dr. John B. Roberts¹ cites two cases of accidental heart puncture resulting beneficially to the patients. In one, that of Roger, "200 grms. of pure venous blood" were withdrawn from the heart. He further says: "Death occurred five months later from long existing dilatation and valvular disease of the heart." In the other, Hulke's case, 4 grms. of venous blood were also withdrawn, and "she died four weeks later from a complication of diseases, and the autopsy revealed cardiac dilatation and valvular changes." He further adds in reference to this case by quoting from a previous paper of his, as follows: "The abstraction of the blood seemed to relieve the distended heart much better than phlebotomy would have done, as was evinced by the diminution of threatening symptoms and the decrease of the area of dulness." Additional references are given in support of the claim of the absolute harmlessness of cardicentesis.

In referring to Dr. B. F. Westbrook's point of selection for the introduction of the needle,² Dr. Roberts is inclined to prefer entering the right ventricle "through the fourth interspace, about one and a half or two inches to the *left* of the median line of the sternum." He, however, yields the point of deference in Dr. Westbrook's favor.

In listening to Dr. Roberts when he read his paper on "The Surgery of the Pericardium" before the Anatomical and Surgical Society of Brooklyn, N. Y., in 1881, I heartily endorsed all he said, and at that time was convinced that divulsion of the cardiac orifices in case of stenosis would be a safe and practicable operation.

I have previously said that Dr. Westbrook's single operation of cardicentesis was successful. I reiterate that statement. Here is what he says in his report of the case: "As I was anxious, however, to avoid any possible risk of increasing the peril of *any* patient, I chose for the subject of the operation, which I am about to describe, a case *in which all chance of recovery had disappeared.*"³ The first attempt was a failure, inasmuch as the needle penetrated the aorta, and the operation was abandoned, although the needle had been taken from the aorta and placed in the auricle. Later on it was tried again as a last resort, and about 100 grms. of fluid blood were withdrawn. The patient was more comfortable as a result, and expressed himself as feeling much better. The doctor had only hoped for palliation in this case, he obtained it, thus

¹ See a paper by Dr. John B. Roberts on "Heart-puncture and Heart Suture as Therapeutic Procedures," read before the College of Physicians of Philadelphia, January 3, 1883, and appearing in the *Medical News* of January 13, 1883.

² In the right third intercostal space close to the sternal border.

³ Italics my own.

far he was successful. If a man accomplishes what he desires to do, he is undoubtedly successful. I, too, believe with him that had the operation been performed sooner, and had there been much more blood abstracted (probably 300 grms.), complete recovery might have followed.

In the proceedings of the Brooklyn Pathological Society¹ will be noticed a case reported by Dr. B. F. Westbrook, in which he says his operation would have done undoubted good had it been performed. Replying to several inquiries he further expresses himself on this subject. I quote the whole paragraph :—

“In reply to questions from Dr. Wunderlich, Dr. Wallace, and others, Dr. W. stated that bleeding from the peripheral veins was not at all equivalent to direct abstraction of blood from the right heart. On such desperate cases as those for the relief of which he advised this procedure, the blood is found accumulated in the great veins of the trunk and head. The arteries were poorly filled, and the peripheral veins almost empty. Though blood could, of course, be abstracted from them, it would not run backward from the great veins themselves, owing to the valves, but would have to come around through the poorly-filled arterial system, and the flow would be so slow that collateral channels would serve to undo most of the good that was being done; and before any appreciable effect could be exerted upon the right heart, all the blood that would flow would have been abstracted. What was necessary in such a desperate case was to rapidly diminish the flow of blood into the right ventricle, in order to allow it to empty itself and regain its equilibrium. He thought the danger in puncturing the heart was greatly overestimated. The heart is, in reality, the toughest, most long-enduring organ in the body, and, unless it were clumsily done, such an operation as he advised would do no harm. He also wished to call attention to the fact that he only advised it in desperate cases, where there was no hope of relief from other less radical measures.”

I wish to take exception to but one thing in the above quotation, and that is the last expression. There is no reason to my mind why this operation should be a “*dernier ressort*” to be used *in extremis*. I wish to recommend, as I understand Dr. Roberts intends, that if this operation is to be done at all, it should be done as early as possible. We have every inferential reason to believe that it is *harmless*, and whatever practical knowledge there is on the subject only tends to justify the inference that it is devoid of danger.

The lack of a thorough knowledge and of a perfect acquaintance with physiological and pathological rules and processes makes the majority of the members of our profession timid. It is altogether inexplicable to me, after a careful study of this subject, how it can be that this simple operative procedure has been so strongly objected to, unless the objections are based entirely on erroneous conclusions resulting from a defective consideration of this question. My closing sentiment is to let the anatomist, pathologist, and surgeon persevere and conquer, that he may prove to his stationary brethren that the end of possibilities is as yet afar off!

¹ Published in the “Proceedings of the Medical Society of the County of Kings” for Oct. 1883.



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