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*Presented by  
the Author*

ON THE  
THERAPEUTIC USES OF COMPRESSED AND  
RAREFIED AIR

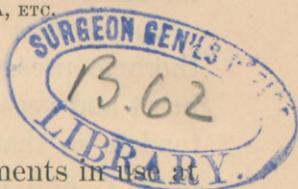
(BEING A REPORT OF REMARKS MADE TO THE COLLEGE OF  
PHYSICIANS ON THE OCCASION OF A DEMONSTRATION  
OF WALDENBURG'S APPARATUS BY DR. JAMES  
TYSON FOR DR. WILLIAM PEPPER).

By ✓

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[Communicated Feb. 2, 1876.]



I HAVE one of Waldenburg's instruments in use at my office, and should be very glad to have heard the results of Dr. Pepper's experiments as far as they have gone. For my own part I should require a much longer experience in the use of this appliance before committing myself as to its utility, although the reputation of Waldenburg, who is likewise the author of one of the best works on tuberculosis, is such as to command the most respectful consideration; and Waldenburg has, in his recent work on the pneumatic treatment of diseases of the respiratory and circulatory organs, advanced sufficient proof of the great value of this mechanical treatment in remedying certain physical defects unattended with organic change. In my own opinion emphysematous dilatation of the pneumatic vesicles from asthma and chronic bronchitis

would be the condition which would be most benefited by this method of treatment; and chiefly by forced *expiration* into *rarefied* air. The only instance in which I have as yet had a fair opportunity to test the value of the apparatus, apart from all other treatment, has been a case of emphysema with asthma, in a young lady who has suffered from asthma from her earliest recollection, and in whom the relief to respiration has been marked after each use of the apparatus, and in whom the vital capacity has increased from 1400 cubic centimetres to more than 1600 cubic centimetres in the course of one month. The use of compressed air is also indicated in cases of deficient expansion of the air-cells.

*Inspiration* of *compressed* air increases the intra-thoracic pressure, including of course that upon the heart and vessels; and the arterial walls are thus distended, so that the pulse becomes diminished in frequency, and full and hard at the same time. The treatment is indicated in dyspnoea from inefficient inspiration, whether cardiac or pulmonic, but it must not be pushed, lest it rupture the air-vesicles in delicate subjects.

*Expiration* into *compressed* air diminishes the quantity of air leaving the lungs, impedes the interchange of gases, and, if pushed, will produce apnoea. It is indicated in deficiency of normal expiratory power, to strengthen the auxiliary muscles.

*Inspiration* of *rarefied* air diminishes the amount of air inspired, diminishes the intra-thoracic pressure, and augments the external pressure on the chest. It enfeebles the action of the heart, and the pulse becomes soft, compressible, and more frequent. Pushed to

excess, inspiration becomes difficult; and apnœa may result, and even hæmoptysis.

*Expiration* into *rarefied* air increases the amount of air expelled from the lungs, and causes the chest walls to contract to a much greater degree than is possible by the most powerful voluntary expiratory effort. A greater amount of carbonic acid is expelled, and the succeeding inspiration is deeper and more refreshing. It thus increases the respiratory power, augments the vital capacity, and, in patients the walls of whose chests are still to some degree movable, tends to diminish the volume of emphysematous lungs and facilitate the restoration of the elastic contractility of the over-distended air-cells. The intra-thoracic pressure being diminished, blood accumulates in the intra-thoracic organs, and is withdrawn from the periphery of the body. The treatment is indicated in chronic bronchitis and in emphysema.

Thus from a study of the mechanical influences of augmented or diminished pressure upon the interior of the air-cells, and upon the intra-thoracic organs generally, we can judge of the propriety or impropriety of the practice in any given instance. Considerable caution is necessary in the use of such a powerful agent as compressed air, especially when inspiration is not supported by an equal amount of pressure on the exterior of the body as is the case in the compressed air-chambers, therapeutic apartments which apparatuses like that before us are intended to supersede. Where the pressure in the arterial system is already great, where there is congestion, or a disposition to congestion in important peripheral organs, as in

patients with internal hemorrhoids, menorrhagia, disposition to apoplexy, etc., the use of compressed air is strongly contra-indicated, no matter what may be the direct physical result desired in the intra-thoracic cavity. In converse manner, rarefied air, which draws the blood from the periphery to the central organs, is contra-indicated in all cases in which increased afflux of blood to the lungs is to be avoided, and in cases of insufficient pressure upon the arterial system already present, as in disposition to hæmoptysis, active congestion of portions of the lung-tissue, weak heart, and so on.

The efficient use of the apparatus before us, and all of the same kind, requires from fifteen minutes to half an hour each time that it is employed. It is evident, then, that it will not come into use in general practice, but is more applicable to hospital practice provided there are attendants who can devote a proper amount of time to superintend its use. For the reasons mentioned, it is hardly a safe apparatus to place in the hands of patients, for fear of the injurious results that may arise from its over-use. In the compressed air-chambers employed on the Continent of Europe for some thirty or forty years, the entire surface of the body is exposed to the same pressure, and thus a much greater amount of compression or rarefaction can be resorted to than in the use of an apparatus which limits the action to the respiratory surfaces. In the compressed air-chambers they use from three-sevenths to two-thirds of an atmosphere compression; with this apparatus we dare use but from one-eightieth to one-thirtieth of an atmosphere; and this is to be exceeded only with great circumspection. Still the portable

apparatus is to be preferred to the air-chamber because the remedial agent can thus be brought within the reach of the patient at his own home.

Some ten years ago, when engaged upon the first edition of my treatise on inhalation, I made some attempts to devise an apparatus for administering compressed air, and thus superseding the air-chambers. I first employed a kitchen bellows, then a condensing syringe and capacious reservoir, and subsequently a large acoustic bellows, but was unable to secure uniformity of compression, and this, with the lack of clinical material to work upon, led me to abandon the attempt; I was, however, very glad when I saw that others had succeeded, and in the edition of the work referred to which has just issued from the press, I have presented a succinct account of the subject, with illustrations of several forms of apparatus, including the one before the College. I would state, before concluding, that an apparatus in the form of an accordeon has been devised by Fränkel for the home use of the patient. The mouth being applied with the accordeon closed, the patient breathes into rarefied air as he expands the instrument; and, the accordeon being distended, he breathes compressed air as he closes the instrument. This I regard as very ingenious, but rather tiresome for patients; and I think that an apparatus to be worked with a treadle could easily be contrived to subserve the same purpose.

Finally, I would say, that there are some simple methods of increasing or diminishing the intra-thoracic pressure at will, without the aid of any apparatus at all, and which may be resorted to with advantage under appropriate circumstances. These are: (1)

Valsalva's method. A forcible movement of expiration, with mouth and nostrils closed, increases the intra-thoracic pressure, and has the same physical effect as the inspiration of compressed air; and the effect can be increased by external compression of the chest and abdomen; (2) Deep and prolonged inspirations with mouth and nose closed, will expand the chest and rarefy the air in the lungs, and the effect is the same as that of the inspiration of rarefied air; (3) Expiration aided by external compression of the chest and abdomen has an effect similar to that of expiration into rarefied air.

These movements may be occasionally substituted for the gymnastic exercises of the pneumatic apparatus, in cases in which the muscular efforts to produce them would not be injurious; but as a matter of course less effort would be required with the use of the apparatus, which will also fulfill indications for which the substitutes are incompetent.

[In connection with Dr. Cohen's remarks, Dr. John H. Packard reported the following case:—]

A boy four years of age was the subject of a very insidious attack of pleurisy of the left side, in February, 1875. The effusion into the pleural cavity was such as to produce the most threatening symptoms, and about four weeks after the beginning of the disease, with the consent of Dr. J. F. Meigs, who saw the patient with me, I drew off eighteen fluidounces of sero-purulent liquid by means of the aspirator. Great relief was immediately given, and there was no reaccumulation. The little fellow slowly recovered, but when the family went into the country, in May, the left thorax was still very much contracted, and the breathing on that side very imperfectly accomplished.

His father procured him a horn, and encouraged him to blow it, by way of salute to vessels passing on the river. The exercise thus afforded the muscles of the chest-walls was highly beneficial, and on the return of the family to town, in November, I found the thorax in excellent condition, the respiration on the left side being fully restored. The child's general health was perfect, and his appearance that of robust health.

[Dr. Cohen said:—]

The effect is similar to that recorded by Laennec, who saw good results sometimes in asthma, from making his patients count aloud as fast and as long as they could. This exhausted the residual air of the lungs, and was like breathing into rarefied air, and the subsequent inspiration was therefore more vigorous and effectual, and sometimes sufficiently effective to overcome the spasm.





