I have, moreover, myself brought forward evidence, both from actual experiment and from stethometric measurements, which proves that the upper ribs, as well as the lower, are usually pliable to a considerable extent in living subjects (*Proceedings of the Royal Society*, No. 139, 1872); and the fact that, in forced breathing in man, a distinct change takes place in the chord-lengths of the ribs, may readily be demonstrated by means of measurements with suitable callipers.*

It is important that the fact of this bending of the ribs should be fully recognised before an attempt is made to explain by what forces it is produced, and the discussion of the difficult question of its causation should not be allowed to prejudice the observations upon which it rests. That the ribs do bend in forced breathing, may be seen by any one who will use the suitable instruments; how they are bent, is much more difficult to prove. It is, however, necessary that the subject should be fully considered, and I venture to adduce the following reasons for assigning to the intercostal fibres a large share in the work.

Since the change in the curvature of the ribs takes place, not only in the lower portions of the thorax to which the diaphragm and abdominal muscles are attached, but also as high as the third, or even the second, pair of ribs, it is evident that it must be effected by some of the intrinsic thoracic muscles.

But it is probable that no muscles are so advantageously placed for performing this duty as the intercostal fibres. When the first ribs are fixed by the cervical muscles, and the lower ribs are drawn downwards and even inwards by the abdominal group, then any fibres between the other ribs acting in concert, whatever their direction, will necessarily draw inwards the intervening bony hoops.

The shape of the thorax is such that, if the ribs below the first are capable of being bent, they must be drawn inwards by the contraction of muscles placed between them.

From the first to the seventh, the rib-circuits descend in widening diameters, and the planes of the intercostal spaces, instead of being vertical, are more or less inclined. The force exercised by the muscles in these

spaces may therefore be resolved in a vertical and a horizontal plane; and the amount of power drawing inwards along the latter plane will, *ceteris paribus*, depend upon the obliquity of the intercostal plane, and will be greatest in the upper part of the thorax. The tendency throughout, wherever there is any slope at all, will, however, be inwards.

Let r_2, r_3, r_4, r_5 (fig. 1), represent transverse sections of the second, third, fourth, and fifth ribs respectively; then any force acting between two ribs, r_2 and r_3 , in the direction of the intercostal space, $r_2 r_3$, may be represented by the lines drawn in the directions x and y , at right angles to one another, and the lengths

of these lines will depend upon the obliquity of $r_2 r_3$. Moreover, the oblique direction of the fibres of the intercostal muscles adapts them still more especially for a constrictor action.

When two elastic bands (A B and C D) are stretched crosswise between

Fig. 2.

two bars (RP and R'P') capable of being bent laterally, but not from above downwards, and which can only be approximated to a limited extent, then, when this approximation has been produced, the tendency of the further action of the bands is to draw together the ends of each bar. In the language of mechanics, the forces they exert may be resolved in the directions RR' and RP, or R'P' and *vice versa*. When the bars are quite straight, no moving effect will follow, since the bars cannot then yield to the forces acting along RP or R'P', but they will be in a position of unstable equilibrium, such that the slightest curvature in the bars will at once permit the bands to contract, and a further bending will take place in the direction of the curvature so introduced.

Now, this latter case is precisely that of the ribs when acted upon by both external and internal fibres at one time, and since the rib-levers are free to move at their anterior extremities, and are more pliable and

thinner at these points, it follows that the chief bending action will take place in the anterior wall of the chest, and a general indrawing of this part of the thorax will be the result. The effect of each fibre, or of each pair of fibres, is necessarily very small, but the aggregate power they can exert is probably quite sufficient for the purpose.

It is interesting to notice that in other parts of the body, wherever constriction of a cavity is required, there we find an oblique arrangement of muscular fibres, generally in two layers, running in opposite directions: in the abdomen, the external and internal oblique muscles; in the pharynx, the middle constrictor spreading fan-like, with its outer fibres directed across those of the upper and lower muscles. In the bladder and stomach, the same arrangement is to be observed; and even in the heart, although the muscles are spiral in their arrangement, their fibres are so placed that they run in a similarly opposed fashion.

Viewed in this light, the intercostals may perhaps be regarded as two large muscles, having, like the rectus abdominis, ligamentous or bony portions placed at intervals in their course, modifying, and in some ways increasing, their power, but not altogether preventing them from exerting a combined influence, and so constricting the cavity of the chest.

This account of the *united* action of the intercostal muscles, working in concert with the external muscles of expiration, does not clash with the received doctrines respecting the inspiratory functions of the external intercostal, and intercartilaginous muscles acting either independently, or together with the cervical and levator muscles of the ribs. The experiments of Traube on rabbits seem to be absolutely conclusive on this point. (*Experimentelle Untersuchungen*, p. 158.)

Again, the rib-depressing power of the internal intercostal muscles acting alone would still be possible, and they might also combine with the abdominal muscles to draw down the ribs after they had been raised by the levatores costarum and the other inspiratory muscles.

It is highly probable, also, that in the upper regions of the thorax the triangularis sterni assists in the process of constriction, and that the diaphragm and abdominal muscles produce some portion of the inbending of the ribs below the sixth.*

The question of the indrawing and constriction of the chest-wall during forced expiration is not without much practical importance, since it bears closely upon the pathology of emphysema, and its production by asthma and chronic bronchitis.

In making stethometric observations upon persons suffering from bronchitis or phthisis, I have often noticed that, whilst the patient has been making forced efforts at breathing, cough has come on, and the ribs have been immediately drawn inwards to a far greater extent than had been accomplished voluntarily, showing that the reflex stimulation of the muscles of expiration, by irritation of the bronchial mucous membrane, was able to accomplish far more than the power of the will.

Now, if in forced expiration, as in coughing, the lung should be compressed by the direct force of the indrawn ribs, then in the natural condition, this pressure will take place at the most favourable moment, when the lung is already partially emptied of air, and when the squeezing effect will be comparatively harmless; but if there be any obstruction to the free exit of air, as in bronchitis or asthma, then the lung will be caught in the position of partial inspiration, and, so to speak, will be taken at a disadvantage, with all its cells distended with air, and ready to be forced into any inequalities in the compressing walls. Here, then, we have an intensification of all the influences which have been considered as the expiratory causes of emphysema.

The subject is not without interest also in relation to the peculiarities in the movements of the chest-wall in pleurisy, emphysema, chronic bronchitis, and phthisis; but on these points I must refer to a paper on "The Respiratory Movements in Man", published in the last volume of the *Medico-Chirurgical Transactions*.

SEVERE HÆMORRHAGE FROM TELANGIECTASIS OF GUM.

By JAMES E. ADAMS, F.R.C.S.,
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THE following case appears to me to be of sufficient interest and importance to justify its isolated publication; and I am the more desirous to place it before the profession, as I believe it to be a somewhat rare

* On these points, I would refer to Mr. Le Gros Clark's "Remarks on the Mechanism of Respiration", *Proceedings of the Royal Society*, vol. xx, p. 122; to a paper "On the Action of the Intercostal Muscles", by Dr. Dwight, jun., in the *Boston Medical and Surgical Journal*: to the first of Professor Humphry's Lectures on "Human Myology", delivered before the College of Surgeons; and to some remarks of my own "On the Action of the Intercostal Muscles", in the *BRITISH MEDICAL JOURNAL* for October 26th, 1872.

* Also the subject of a communication to the Royal Society, but not yet published in the *Proceedings*.

occurrence. At any rate, I have never seen another like it; and, in my hasty search through a few books, I can find an account of one case only of the same kind, recorded by Mr. Salter in Holmes's *System of Surgery*.

My patient, who was sent to me by Mr. Hewitt of Kensington, was a young man about twenty years of age. When I first saw him, I was struck with his exceedingly blanched and waxy appearance. His face more resembled that of a person actually dead from hæmorrhage, than that of one able to move. Between two and three years ago, he had the first right upper molar extracted. No particular bleeding occurred, and the gum healed. About six months later, hæmorrhage began to occur at intervals from the gum at the site of the cicatrix—first in small quantities; subsequently more copiously and more frequently, until latterly there was hardly ever a space of twenty-four hours without bleeding. It often occurred at night; and, the mouth filling rapidly, he was on more than one occasion nearly suffocated. Having ascertained that there was no history of hæmorrhagic diathesis, I came to the conclusion that there must be some kind of vascular tumour, though I could not see it at the time, as the surface was covered with clot, which I did not remove until I was prepared with the galvanic cautery. This being ready, I wiped away the clots, and discerned a small plexiform nævus on the surface of the gums, between the second malar and bicuspid teeth. It immediately bled from three points in continuous jets, each stream being equal to that of a digital artery at the metacarpo-phalangeal joint. A free application of the cautery at once arrested the bleeding and completely destroyed the growth. There has been no bleeding since. It is somewhat difficult to understand how the patient could have allowed it to go on so long, he having had absolutely no advice until he saw Mr. Hewitt only the day before he was sent to me.

REVIEWS AND NOTICES.

CONTRIBUTIONS TO SURGERY AND PATHOLOGY. By CÆSAR H. HAWKINS, F.R.C.S., F.R.S., Surgeon to the Queen, Consulting Surgeon to St. George's Hospital, etc. 1874. (Printed for private circulation.)

ALL MR. HAWKINS's friends and pupils will rejoice on seeing this volume, to think that what has long been a source of regret to them has at last been remedied; viz., that the numerous papers and clinical lectures from which they derived so much instruction during their early days of learning are no longer scattered about in the pages of various periodicals of widely differing dates, but are collected and accessible in a single work. And all those who cultivate the science and art of surgery will be well pleased to know where to find such ample and such good material as Mr. Cæsar Hawkins's papers furnish on almost every part of surgery and pathology. Our only regret is, that Mr. Hawkins did not give them a wider circulation by publishing them in the ordinary way, instead of merely sending round a limited number of copies to his friends and to the journals and public libraries. We hope, however, that the latter have been freely supplied, so that readers may know where to consult a work which must always be referred to as an important authority upon the matters which it handles.

To give an adequate idea what those matters are is difficult in the compass of a notice like this; they embrace papers, of which the earliest (on the contagion of small-pox after death) was published at the beginning of 1829, whilst the latest seem to be a course of clinical lectures in 1854. These papers are one hundred and six in number, besides three very interesting occasional addresses, and a note "On the Relative Claims of Sir Charles Bell and Magendie to the Discovery of the Functions of the Spinal Nerves", the substance of which appeared in the *BRITISH MEDICAL JOURNAL* so lately as 1868.

Even had these papers no other value than the historical interest which is all that Mr. Hawkins claims for them, the book would be an indispensable contribution to the surgical literature of the present day. But this is far from being the case. Mr. Cæsar Hawkins has long been esteemed one of the greatest masters of the art of surgical diagnosis, and diagnosis is a matter which is not affected by the changes of time and fashion. To instance only two of the many subjects treated of in this work—the observations on the diagnosis of the various forms of ulceration of the tongue, contained in vol. i, pp. 214-217, and those on the diseases of the testes, vol. ii, pp. 274-290—are as fresh and as valuable at the present time as they were at the moment of their delivery, and will well repay the perusal of any practitioner, whatever may have been his experience. There are some subjects which Mr. Cæsar Hawkins made more peculiarly his own; such are the subjects of tumours in cicatrices, and of congenital tumours in the neck, the original papers on which will be perused in these volumes with interest, but

are already familiar to all surgical students. The celebrated courses of lectures also on tumours in general, though the description of its subject has now been modified, remains as one of the great landmarks of that department of surgical pathology, and its perusal is indispensable to any exhaustive knowledge of the subject.

It is, perhaps, less known that Mr. Hawkins was for a long while the only surgeon who had performed ovariectomy with success in a metropolitan hospital; and it is very interesting to read his careful and judicious remarks on the then vexed question as to the justifiability of the operation (vol. i, p. 137), delivered in the year 1846, at a time when many surgeons altogether repudiated the proposal. They show that, though no reckless innovator, Mr. Cæsar Hawkins was equally far from being opposed to any novel proposal merely on account of its novelty. Another new operation which he did very much to introduce into general notice and reception by his successful practice is colotomy, and the celebrated paper which he wrote on this topic in 1852 (vol. i, p. 100) forms one of the leading authorities on the subject. Injuries of the head, injuries and diseases of the spine, the surgical affections of the whole urinary tract, are parts of surgical pathology which no one who is not acquainted with Mr. Hawkins's writings can have studied adequately any more than he could know them apart from Brodie's writings.

There is in fact much in common in the career and in the writings of both these great lights of the St. George's school. Both were most distinguished in the highest province of their art, and obtained fame more as correct diagnosticians and judicious practitioners than as mere manipulators, although both could be as daring in the operating theatre, when necessary, as any surgeon should be. Yet, as a general rule, Mr. Cæsar Hawkins was more anxious to teach his pupils how to avoid an operation than how to perform it; how to save the leg rather than how to cut it off. Those who enjoyed the great advantage of his teaching will always look back to him as the model of a sagacious and successful surgeon. Those who had not that inestimable opportunity may, from these volumes, form an idea, however inadequate, of the grounds on which that reputation was based. The whole profession, which looks up to him as one of its highest ornaments, and derives lustre from his extensive attainments and character of stainless honour, will join in congratulating him on his having left in these volumes so worthy a memorial of a long career of distinction and usefulness.

TYPHOID FEVER: ITS NATURE, MODE OF SPREADING, AND PREVENTION. By WILLIAM BUDD, M.D., F.R.S. London: Longmans, Green, and Co. 1873.

ALTHOUGH the communicable nature of enteric fever is, to some extent, even in this country, admitted, it is yet believed to be so slight, that in practice it may be disregarded. This has probably arisen from our notion of communicability having been derived from small-pox, measles, typhus and scarlet fevers. The rapid and extensive spread of these diseases has compelled attention to communicability as one of their most important characters. But, although enteric fever may not spread exactly in the same way or to the same extent as the diseases referred to, and though we may think Dr. BUDD mistaken in referring enteric fever to the class of diseases which we have just mentioned, we firmly believe that it is more communicable than it is thought to be; that, like cholera, it may be introduced into a house or a locality by a single case, from which the disease will spread as an epidemic. The importance of this doctrine for which Dr. Budd contends—although we may not be prepared to admit, with him, that it is the "master-fact" in the history of the disease—can hardly be overrated; and its almost total disregard by the public and the profession, apart from other obvious considerations, more than justifies Dr. Budd in placing before the profession, in a completer form than he has hitherto done, views of which he has long been the able advocate.

Dr. Budd's contention is, that enteric fever is essentially a contagious disease; that the contagious matter is contained in the intestinal discharges; that this matter reaches the human body by means of air and water, and that its presence is necessary and equal to the production of the disease. In support of these propositions, Dr. Budd gives several illustrations, three of which appear to us so important, that we make no apology for narrating them at some length. The village of North Tawton had enjoyed a marked immunity from enteric fever, when, on July 11th, 1839, a first case appeared. This case was soon followed by others, and, from the last-mentioned date to the beginning of the following November, "more than eighty of the inhabitants had suffered"—truly a mighty epidemic for a small village. But, says Dr. Budd, "during the prevalence of the fever in North Tawton, it so happened that three persons left the place after they had become infected. By a fatality—which is but too common under such circumstances, all three