ON RESPIRATORY CONVULSIONS, WITH ESPECIAL REFERENCE TO LARYNGISMUS STRIDULUS AND ALLIED CONDITIONS IN INFANCY.

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THE young man who commences the practice of medicine amid the crowded population of one of the great manufacturing cities of England becomes very speedily aware of the frequency and importance of certain signs of nervous disturbance in the young infant, which will form perhaps the most frequent, and certainly the most urgent, of the causes of his summons to assist. Of the total number of deaths of children under the age of one year in England, three-tenths are from some form of nervous disease, and of this proportion nearly three-fourths (73.3 per cent.) are returned as due to convulsions. These figures are doubtless imperfect, and due largely to insufficient diagnosis, but they serve to illustrate the frequency of the symptom in early infancy, and the gravity and importance of its study; for great as may be the mortality indicated by these figures, yet convulsions are but, by comparison, rarely in themselves the cause of death. When this does occur, it is usually by spasm interfering with the functions of respiration and circulation, and hence there is a peculiar fitness in making those forms of convulsion which especially affect these organs the subject of our first consideration.

By convulsion, or, as it is popularly called in this country, "a fit of convulsions," is signified an attack of recurring spasms of the voluntary muscles, consisting of energetic alternate contractions and relaxations of particular muscles or groups of muscles. These are due to irritation of some portion of the nervous apparatus governing the movements of the affected parts—an irritation which may be local, of the nature of a distinct entity, as a lesion or a tumour, or, as is generally the case in infancy, general, as a nutritive defect or morbid diathesis, or a toxic condition of the blood, as *anæmia*, rickets, imperfect aëration, or *uræmia*.

Now, there are, as Hughlings Jackson¹ has pointed out, three levels or grades of motor centres, varying in the degree of complexity with which they represent muscular movements, and also in the period of their evolution. The first to be evolved in point of time, and the lowest in point of complexity and also in position, consists of the grey cells of the anterior cornua of the spinal cord, of the medulla oblongata and pons; and the nuclei of the ocular muscles in the floor of the aqueduct of Sylvius, are the highest of these lower motor centres. This grade also includes the centres for the regulation of nutrition and respiration and for vaso-motor action. The second grade, or middle level, includes Hitzig and Ferrier's motor centres in the cerebral cortex, Schäfer and Victor Horsley's trunk centres, and Ferrier's sensory region.² The third or highest grade includes the brain in front of the middle motor centres, namely, the frontal or prefrontal lobes and the part behind the middle sensory centres. The first and lowest of these levels or grades represents all parts of the animal (indirectly indeed, but most nearly directly of all) in co-ordinated groups; the second grade represents the same parts, but doubly indirectly and in co-ordination of greater complexity; while the third or highest level represents them trebly indirectly and in co-ordination of still greater complexity.³

Now, as Hughlings Jackson has shown, there are three kinds of fits, or convulsions, which affect mankind. First, epileptic fits, depending upon discharging lesions of the highest centres, those of the third grade or level, and the last in order of evolution. Secondly, epileptiform, depending upon discharging lesions of the middle or second grade centres, both cortical and central. And, thirdly, respiratory convulsions, which depend upon discharges of the centres of lowest grade or level, the first in order of evolution. Laryngismus stridulus, spasmodic asthma, the fits which occur in whooping-cough, those produced in rabbits by Brown-Séquard and Westphal, and in guinea-pigs by Kussmaul and Tenner, are all examples of these lowest level fits, while those convulsions which commence in one hand and the like are examples of middle level or epileptiform, and those which commence with epigastric or cephalic sensations, of the highest level fits, or epilepsy proper.

In the newly born child, the lowest level forms almost the whole of

the developed nervous system, the higher levels being at this period in a condition but little advanced from the fetal, and even these lower centres are probably not yet fully evolved. The centres for respiration, circulation, and digestion are all at this time in a state of the most active development, the respiratory perhaps the most active of all; and as the higher grades are still so little organised, they can exercise but slight controlling power, and these former centres are easily excited. Hence the greater frequency of fits of this character in the young infant. "The younger the infant," says Jackson, "the more of a mere ordinary reflex mechanism will there be in what there is of its nervous system, and the less check will there be of one part by another."

Varying in degree from the slightest flicker of movement about the lips and facial muscles, a fleeting smile that passes over the face of the sleeping infant, the "angel's whisper," as the mothers poetically call it, to the most severe and universal convulsion, these lower level or respiratory fits are most frequent between the ages of 4 months and 2 years, the period when the dental evolution is most active, and they most frequently affect children of rickety tendencies. Some writers have gone so far as to say that children affected by laryngismus stridulus, which represents most distinctly though not exclusively this class of fits, are always rickety. Of these, Elsässer,⁴ who thought that defective ossification of the bones of the skull was the determining cause, has been followed by a large number of later observers, who, however, only see in that particular manifestation an example of a general condition more likely to be effective as an exciting cause through the defective nutrition producing a condition allied to *anæmia*, or, as Hughlings Jackson thinks, from the weakness and deformity of the chest-walls interfering with the proper and complete aëration of the blood; for, in the venous condition of blood circulating through the pulmonary vessels, we have the natural and most powerful stimulus of the respiratory centres, and a condition which, if rendered permanent by defective expansion of the chest-walls, must lead to continual excitement and irritation of those centres. But though this venous condition of the blood is the most powerful and immediate of the exciting causes of this class of fits, I am not prepared to admit that it is the only one.

In the first place, *anæmia* from whatever cause is probably the most frequent cause of convulsion, and so nice is the physiological balance between the blood and the organs of the body, that each one by its own proper action renders the nutritive fluid more suitable for the others, and the starvation of one tissue renders the blood less fitted to be the pabulum of the rest, and from this results a continual though partial *anæmia*, leading in the end to similar results as an actual loss of blood. Moreover, in the young child, from the great preponderance of lower level centres, almost any peripheral irritation may manifest itself as convulsion.

A child may be sucking eagerly, when suddenly he will let the nipple drop, and make one or two crowing inspirations, perhaps accompanied by a squint, and a slight movement of some of the facial muscles, then will follow a discharge of flatus, and in a moment or two he will turn again to the breast. Here the exciting cause was evidently gastric, and although it is customary in modern days to deny the influence which a former generation attributed perhaps too universally to the dental evolution, yet there are many, and myself among the number, who are inclined to believe that the pendulum has in this instance swung too far in the other direction, and that intimately associated as these phenomena are with the gastric system, and connected as this class of fits is with the period of that evolution, irritation connected therewith must be ranked as one of the exciting causes. But in these cases there is also existing a predisposing cause in the centres themselves, already in an excitable or irritable state; a condition of instability, brought about it may be by a slight but persistent degree of venosity, perhaps also temporarily increased by obstruction to the movements of the diaphragm, as by flatus, or undigested food. In fact it is with the centres of the lowest level, as with those of the higher, the instability of the nerve-cell is the true nidus, and the afferent nerves connected therewith either directly or mediately constitute its "epileptogenous zone." In short, to quote the words of Hughlings Jackson, a convulsive centre is "a hyper-physiological state of nerve-cells, induced by some pathological changes, which changes lead to increase but yet, I think, inferior nutrition."

The obstruction to the circulation becomes evidenced when the case is prolonged by swelling of the backs of the hands and the dorsum of the feet. These parts are then often tense and shining, from the *asarca* so induced, and in cases of severity and long standing the urine is albuminous. The attacks frequently occur on waking from

¹ Hughlings Jackson, "A Contribution to the Comparative Study of Convulsions," *Brain*, April, 1886.

² Ferrier, *Functions of the Brain*, 2nd ed. London, 1886.

³ Jackson, *loc. cit.*

⁴ Elsässer, C. L., *Der weiche Hinterkopf*, etc., Stuttgart, 1843.

sleep; it might be thought that it was the onset of the convulsion that awoke the child, but I have clear testimony that in cases where a child has been sleeping quietly, he has, when awakened by the nurse, immediately been seized with a fit. The minor manifestations of spasm in the facial muscles ("the angel's whisper") are frequently seen during sleep. As the attacks become more frequent, the obstruction to respiration becomes more marked, and there is frequently a manifestation of carpo-pedal contractions, a condition which has been named "tetany," and consists of a rigid contraction of the hands and feet, the thumbs drawn in to the palms of the hands, and the fingers clenched or sometimes adducted, so as to form a sort of cone such as the accoucheur assumes in certain cases, and hence termed the "accoucheur's hand." This condition is sometimes seen in adults, and has been described by Trousseau as peculiar to women who have been over-suckled, or the subjects of severe diarrhoea.

The onset of the convulsion is too rapid to be easily traced, but it often commences in the muscles moving the eyes or the angles of the mouth, and the march of spasm involves the hand, forearm, upper arm, face, thigh, and foot of the same side, extending thence to the bilateral muscles, and finally to the unilateral muscles of the opposite side. The head is thrown back, the nostrils expanded, the lips protrude as in the act of sucking (evidence of the involvement of the centres of deglutition); the heart's action (first irregular and powerful) becomes weaker and more rapid, pulse small, features livid and the eyes upturned, wrists flexed and feet fixed in the position of varus, and occasionally there is involuntary discharge of feces and urine. The crowing inspiration, which marks the onset of the attack, is lost in the progress of the severe spasms by the almost complete closure of the laryngeal passage, and death ensues from suffocation.

That a disease of this nature should frequently show a character of heredity is not surprising; all observers of large experience have noted this. Dr. John Reid⁵ mentions a family of thirteen children, out of which only one escaped. My own experience has been corroborative, and I can point to many families which have lost two, three, or four children from this cause. These attacks are most frequent in the cold season; Barthel and Riillet thought that the month of March was the most frequent period, but my own experience does not support this view. More boys than girls are the subjects; during the year 1885 the result of an inquiry into 114 cases was as follows:

1885.	M.	F.
January	8	5
February	9	7
March	4	3
April	4	5
May	3	1
June	3	—
July	1	2
August	6	3
September	5	4
October	7	8
November	9	5
December	11	1
Totals	70	44

and in 98 of these cases symptoms of rickets were noted, and 11 died—8 males and 3 females. The fatality here recorded agrees very well with that observed by Reid and Henoch, but is very much below that recorded by Wunderlich (*Handbuch der Spec. Pathologie u. Therapie*, iii), who puts it at one-third, Bouchut at one-half, and Steiner who says that the majority die. Perhaps the cause of this difference is that the latter were hospital in-patients admitted on account of the severity of the attacks, while the former include the milder cases seen at the homes or among the out-patients. Violent and prolonged crying is a frequent cause, acting, doubtless, by reducing the inspirations, and so producing increased venosity, as well as by the exhaustion of the laryngeal muscles.

Very closely allied to this disease is whooping-cough, the ordinary paroxysms of which approach very nearly to the character of convulsions, and in the more severe cases they are actually present, especially in young subjects, and during the first year of life. Of the 114 cases which I have recorded above, 90—namely, 55 males and 35 females—were under the age of 2 years, and of these 16 were under 6 months, and 63 between that age and 1 year. Steiner records of 226 children affected with this form of convulsions, 174 in the first year of life. Convulsions of similar origin are occasionally seen at the onset of severe disease of the respiratory organs. I have seen them precede or usher in attacks of lobar pneumonia, of bronchitis,

and of acute pleurisy, but they are more common towards the fatal termination of these and allied affections. Spasmodic asthma in adults is an occasional cause of convulsions of a similar nature. Enlarged bronchial glands, fatty enlargement of the liver, or, indeed, any encroachment upon the normal respiratory space, may become a factor in the cause. Kopp published a treatise in 1830, in which he attributed this disease to hypertrophy of the thymus gland; but this theory is now quite abandoned, having been quite discredited by the results of a number of necropsies published by Bednar in 1852. Convulsions of this nature have been noticed in adults with pulmonary tuberculosis, associated with enlargements of the tracheal and bronchial glands. Emotion, especially when of a depressing nature, anger, and fright especially, will produce them, when there is the predisposition, and it is by no means an infrequent sequel to the sudden disappearance of a skin-eruption. Indeed, in early infancy, almost any disturbance of the nervous system may manifest itself in this way, and the toxic derangements, which in adult life show themselves as delirium, will in the former case produce convulsions.

Of the *post-mortem* appearances there is nothing special to observe. In the cases most recently examined, nothing has been observed in the membranes or structure of the brain, and it is remarked that the grey matter seemed to be, if anything, paler than usual; but in earlier accounts—perhaps less under the influence of modern doctrines, which sometimes seem to produce a faculty of observation favourable to the views of the observer—there is noted very generally a state of venous congestion, and some fluid in the ventricles. There is rarely any extravasation, and the congestion, when present, is probably a consequence of the convulsions, not a cause. Steffen⁶ sums up the appearances hitherto found as hyperæmia of brain, both membranes and substance, and sometimes effusion of blood: œdema of brain with transudation of fluid between the membranes and into the ventricles: no alteration discernible in nerves or muscles. There is occasionally persistence of the fetal circulation, and dilatation of the right ventricle has been noted. The lungs are often emphysematous from the spasm, and not infrequently there is some œdema of these organs. There may be traces of pneumonia or catarrhal inflammation, or hyperplasia and caseation of mesenteric or bronchial glands, and it may be that occasionally there will be some redness and swelling of the gastric or intestinal mucous membrane.

These spasmodic affections of the larynx have been found also in connection with other toxic conditions of the blood—for instance, in lead-poisoning; and it has been remarked by Löschner⁷ that pneumonia as a complication is followed by abatement or disappearance of the spasm; but catarrh, if the predisposition be present, will bring it on, or if it be disappearing, will aggravate it.

Treatment.—The intimate connection which exists between convulsions of the character which we have been considering, and that dyscratic condition which we call rickets, is the most prominent of the facts which we have hitherto considered. The researches of Kussmaul and Tenner, and the admirable Croonian Lectures of the late Dr. Moxon in 1881, have cleared away the ancient theories of hyperæmia and congestion, and led us to see the true excitant of convulsions, apart from mechanical irritation, in a condition of anæmia, or "kakotrophy." Thus, leaving aside tumours or inflammatory conditions, convulsions follow loss of blood, severe and long-continued drains, such as diarrhoea, superlactation, etc., blood-poisoning, as by uræmia, or the poisons of the exanthematous fevers, etc., when the skin-eruption is suppressed and the like; and, lastly, but most important for our present purpose, when the blood becomes venous from retention of those matters which should be passed off by respiration. It may be objected to this view that asphyxia produces relaxation of muscle, and renders motor centres unexcitable; but it is the case with many other poisons that a large dose paralyses the functions which a smaller one excites and stimulates. A continuous or frequently recurring condition of venosity in the blood circulating through the brain leads to an instability of some of the centres of the lower level, about the floor of the fourth ventricle, and the discharge of even a small portion of these determines, by contiguity, the discharge of others, and finally involves the spinal and general centres. If this be so, then we are led to ask what led to this venous condition of the blood? In laryngismus we have the coincidence of two causes—the malnutrition, evidenced by the rickety condition so frequently present, and the softness of the bones forming the chest-walls, which prevents a full and free expansion of the lungs; and, the predisposition being thus established, a very slight interference, as by flatus, or some other slight cause, is sufficient to determine the discharge. In whooping-cough and in spasmodic asthma a somewhat similar condi-

⁵ Reid, John, on "Infantile Laryngismus," *Lancet*, 1849.

⁶ Ziemssen's *Cyclopædia of the Practice of Medicine*, vol. vii, p. 978 et seq.
⁷ *Aus der Franz-Josef Kinder-spital in Prag*, ii, p. 144.

tion arises, in the former case, due probably to a specific irritation of the entrance to the larynx; while in depressing emotion and the acute affections of the respiratory organs, we have the same results.

The first indication of treatment is, then, self-evident: it is to provide that there shall be no artificial obstruction to free respiration, that the dress shall not compress the throat, or impede the movements of chest or abdomen. That the air shall be pure and warm, so as not to excite reflex spasm by its contact with the tracheal or laryngeal surface. Cold water dashed suddenly over the head and chest will often put a stop to a paroxysm, or a cloth or sponge wrung out of hot water, and applied suddenly to the throat, or, if suffocation seem imminent, the finger introduced into the pharynx, may induce vomiting and relief. The warm bath is a popular and useful mode of treatment, and the vapour seems to have a soothing effect. If the case be severe and prolonged, the administration of chloroform may be useful, but it is to be borne in mind that this will cause some obstruction to the already over-burdened respiration. A preferable mode, if time permit, will be the administration of a starch enema containing from one to three grains of chloral-hydrate, for a child of 1 year. If there be any evident cause of reflex irritation, such as tense and swollen gums, they may be scarified with the lancet, for the relief which undoubtedly often follows is probably more from the effect of the slight bleeding than from any other cause. Ascarides or lumbricoides may be removed by the appropriate means; for the former I prefer rather copious enemata of quassia, followed by *lavements* of warm water, or, if there be straining, by a starch enema, to which may be added bromide of potassium, one to four grains, according to age. If there is reason to suspect the presence of undigested or indigestible food in the stomach, a stimulant emetic of mustard or ipecacuanha, or zinc sulph., may be given. If there be great turgescence and lividity of the face during the fit, and persisting during the intervals, the application of one or two leeches to the nostrils or temples is a practice which has been often beneficial, and which I should not allow any consideration of modern prejudice to induce me to omit, where the case seemed to me to require it. Such a practice, in the case mentioned, is consonant to reason and to pathological physiology; it relieves the turgid and overfilled vessels of the surface, and it reduces in some degree the amount of toxic matter in circulation, both of which are indications that must be advantageous to the patient. But though I say this, it must not be thought that I advocate depletion in these cases; they are, as I have said before, essentially the result of anæmia or malnutrition, and require nutriment and support. The usual measures of hygiene must be thoroughly carried out, and the diet suited to the age of the child; if it is of an age to take other than milk, the juice of meat, or raw flesh itself chopped, and mixed with a small quantity of salt, is often taken well, and of much value, in rickety cases; a teaspoonful being given twice or thrice a day in addition to other food. Lime-water in milk is useful sometimes, but cod-liver oil in doses not too large (the motions being watched and the dose reduced if the oil appears on the surface) has seemed to me of greater value. The clothing must be warm; flannel should be worn next the skin, and changed and aired night and morning; cold or tepid sponging should be employed; and, when the weather is suitable, frequent carriage in the open air, care being taken to avoid cold winds or any undue exposure. If the bowels are constipated, decoction of aloes, or aloin in suitable doses, will be found useful, and small doses of extract of belladonna (one-twenty-fourth or one-thirty-second of a grain), twice or three times a day, assisted by friction of the abdomen with castor-oil, are often effectual, even in obstinate constipation. The bromides of potassium or ammonium are very useful in these cases, the latter seeming to me to be preferable. They may be given alone or in combination with chloral-hydrate, and are well borne by children; one grain of the latter to three or four of the bromide may be given to a child of 12 months, every three or four hours, but they may be pushed, if required, much further. Occasionally the administration of a few grains of grey powder is useful, and, during convalescence, the ferruginous tonics. Musk is also very useful in these cases, in doses of one-third of a grain to one grain for a child of 12 months, and belladonna, previously mentioned for its use in constipation, is valuable as a respiratory stimulant, and is well borne, as much as fifteen minims of the tincture having been given three times a day to a child of that age. The diet of the young child deprived of its mother's milk is too long a subject to enter upon here, but it is in these cases of the utmost importance, and I must again impress upon the reader the fact that this is a disease of impaired nutrition, and that all means must be directed to the remedying of that evil, so that it may be, and sometimes is, advisable to administer stimulants in the form of brandy, and even, as in severe diarrhoea, which is not an infrequent accompaniment, narcotics, as opium.

REMARKS ON AN OUTBREAK OF SCARLET FEVER IN A SURGICAL WARD.

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THE outbreak of scarlet fever in a surgical ward, and its relation to wounds, is a subject of so much interest and importance, and about which we have so few statistics, that the following details of a recent outbreak at the Pendlebury Children's Hospital may prove instructive. The surgical ward is under the care of Mr. Wright, through whose kindness I am permitted to publish the following.

The hospital, which is situated in a remarkably healthy neighbourhood, four miles from Manchester, is a comparatively new one, and is built on the block system; the wards are large and the ventilation excellent, wounds, as a rule, doing remarkably well.

The above is a rough sketch of the plan of the ward, which shows more clearly than one can explain in words the position of the beds of the cases which were attacked with scarlet fever, the number of antiseptic dressings in the ward at the time, etc.

At the time of the outbreak there were twenty-seven cases in the ward, twenty-three with wounds and four without. Five of the cases with wounds had had scarlet fever previously, one of which was infected. Only one of the cases without wounds was infected, none of these having had scarlet fever previously. Of the six cases with wounds that got scarlet fever, only one was dressed antiseptically;