THE POSITION OF THE PRESENT REFORM MOVEMENT IN ANÆSTHETICS.

BY FREDERIC W. HEWITT, M.V.O., M.A., M.D. CANTAB.,

ANÆSTHETIST TO H.M. THE KING; PHYSICIAN-ANÆSTHETIST TO ST. GEORGE'S HOSPITAL; CONSULTING ANÆSTHETIST AND EMERITUS LECTURER ON ANÆSTHETICS AT THE LONDON HOSPITAL.

THE present moment would seem to be a favourable one for considering impartially and dispassionately the precise position of the movement initiated some four years ago with the twofold object of improving the conditions under which anæsthetics are administered and of protecting the public against the employment of anæsthetics by unqualified persons. Owing to the circumstance that during the past few months there has been a diminution in what must be termed the normal frequency of deaths during anæsthesia—a circumstance which is, doubtless, accidental—there is, so to speak, a lull in the clamour with which both the medical and the lay press have been insisting upon the necessity for these reforms. Advantage of this lull may therefore be taken to review the work that has already been done and to consider what further steps are necessary.

It must be obvious to everyone who has had a sufficiently long experience in practical anæsthetics to enable him correctly to gauge the possibilities of general anæsthesia, that this department of practice still lags behind to a lamentable degree in the great advance which modern surgery is now making. It may be said, indeed, that unless a great deal more attention is paid to this subject by those who are responsible for medical education, hospital administration, and the public safety respectively, the community will still be prevented from enjoying, to the fullest degree, one of the greatest of modern discoveries, whilst the progress and practice of surgery, and particularly of certain branches of surgery, will be unnecessarily checked and delayed. The complications and dangers which are now so often and yet so unnecessarily associated with anæsthesia naturally alarm the public and prevent thousands of its members from obtaining that surgical relief which would restore them to comfort or even to perfect health. Were one able to assent to the proposition that the great majority of deaths under anæsthetics are unavoidable one would certainly not be so insistent upon the necessity for the reforms here advocated. But as experience leads one to an absolutely opposite conclusion—namely, that the great majority of accidents are preventable—one cannot too strongly urge the need of paying much greater attention to the personal factor in anæsthetisation. It is this development in *personnel* which is the key to the problem of death prevention.

The present reform movement commenced at the meeting of the British Association for the Advancement of Science held at Leicester in 1907. The question of deaths under anæsthetics was there discussed, and the attention of those present was drawn to the cardinal importance of the personal element in the administration of these agents. The opinion was expressed that in order to reduce the mortality from anæsthesia the first steps necessary were (1) to ascertain whether medical students were being properly instructed in the use of anæsthetics; (2) to bring pressure to bear, if necessary, upon the various educational authorities to improve and extend such instruction; and (3) to represent to all hospital authorities the necessity for invariably placing the administration of anæsthetics in the hands of those possessing special aptitude for this particular kind of duty and sufficient experience to entitle them to undertake its responsibilities. Certain statistics, kindly furnished for the occasion by Dr. F. J. Waldo, one of the King's coroners, were quoted which seemed clearly to indicate that at hospitals in which no special precautions were adopted and in which anæsthetics were often administered by inadequately trained persons accidents were much more common than in better equipped institutions. The various medical examining bodies in the United Kingdom were thereupon communicated with, and it was found that of 22 such bodies only eight required candidates for their diplomas or degrees to produce evidence of having received instruction in anæsthetics.

It may be mentioned in this connexion that in 1901 the then Society of Anæsthetists had unsuccessfully made representations to the General Medical Council asking that instruction in anæsthetics might become an essential part of medical education. In response to such representations the Council expressed the opinion that it was not expedient that anæsthetics "should be compulsorily included as a separate subject of the medical curriulum." The Conjoint Board of the Royal Colleges of Physicians of London and Surgeons of England, however, very properly issued a special regulation that on and after May 1st, 1902, every candidate presenting himself for his final examination should produce evidence of "having received at a recognised medical school and hospital instruction in the administration of anæsthetics to the satisfaction of his teachers." A few other examining bodies followed the lead thus happily set by the Conjoint Board, but it was not until 1907 that the General Medical Council requested all such bodies to require of candidates for their final examinations evidence of having received the instruction in question. This request on the part of the General Medical Council took the form of "Recommendation"—that is to say, the carrying out of the suggestion rested very largely with the examining bodies themselves. At the time the reform movement, now under consideration, was inaugurated this Recommendation of the General Medical Council, although in print, was little more than a dead letter, for, as above mentioned, inquiries made amongst the examining bodies clearly proved that more than half of such bodies required no evidence whatever of candidates for their degrees or diplomas having been instructed in the use of anæsthetics.

In the following year—i.e., in March, 1908—the subject of anæsthesia, particularly in its relation to the public safety, was brought before the Medico-Legal Society, the president of the Society, the late Mr. Justice Walton, being in the chair. At the conclusion of an interesting paper by Mr. Henslowe Wellington, the present writer proposed two resolutions which, having been adopted by the society, were forwarded to the General Medical Council and to the Privy Council respectively. The resolution transmitted to the General Medical Council asked that body to add instruction in anæsthetics to its "requirements" in regard to professional education; that forwarded to the Privy Council prayed that legislation might be initiated whereby the administration of any anæsthetic with the object of destroying consciousness during any surgical operation by any person other than a legally qualified medical practitioner might become a penal offence. It was generally recognised in the course of the discussion upon these resolutions that in addition to the two reforms suggested at the Leicester meeting of the British Association—namely: (1) the thorough training of all medical students in anæsthetics; and (2) the exercise of great care on the part of hospital authorities in regard to the special fitness and experience of those entrusted with the administration of anæsthetics—a third reform, namely, that outlined in the resolution forwarded to the Privy Council, was needed. If the risks of anæsthetics were to be reduced by improvements in *personnel* it was obviously necessary, whilst attempting to introduce the two reforms already mentioned, also to attempt to secure legislation whereby wholly unqualified persons would be prevented from administering the particular class of drugs in question. This third or legislative reform was in reality essential and fundamental. It was, moreover, complemental to the other two, for without such a reform there would be little hope of attacking the problem of death prevention with the proper weapon—that of improved *personnel*. The three reforms thus adumbrated fortunately had the support of the then Home Secretary, Mr. (now Lord) Gladstone, whose interest in the matter at this stage had no small influence in advancing the movement.

The resolution forwarded by the Medico-Legal Society to the Privy Council praying for legislation was referred by that body, on March 27th. 1908, to the General Medical Council. Both resolutions of the Medico-Legal Society thus came before the General Medical Council, which during its session in June of that year expressed itself as inclined to support legislation in the direction suggested, and drew attention to the fact that it had recently issued a Recommendation to licensing bodies in regard to instruction in anæsthetics, and that it had reason to believe that many of these bodies had already given effect to the Recommendation.

At this stage of the movement the Home Secretary in June, 1908, consented to receive and to consider a draft Bill

imposing restrictions upon the use of anæsthetics by unqualified persons. Such a Bill was accordingly drafted by Mr. Digby Cotes-Preedy on lines suggested by the present writer, and having been submitted informally to various leading members of the profession and to the late Mr. Justice Walton, Sir William Collins, Mr. C. S. Tomes, and others, was forwarded to Mr. Gladstone in August, 1908. This Bill,[1] which dealt only with general anæsthetics and which proposed to prohibit all persons other than (1) present and future registered medical practitioners, and (2) dental practitioners registered before the passing of the Act, from administering any general anæsthetic, including nitrous oxide, for any medical or surgical operation, act, or procedure, or during childbirth, was considered by the Home Secretary and subsequently referred by him to the Departmental Committee on Coroners' Law, whose labours were then about to commence. It was also referred to the Privy Council, who subsequently forwarded it to the General Medical Council for their consideration and report.

At the meeting of the British Association for the Advancement of Science held in Dublin in September, 1908, the subject of the prevention of deaths under anæsthetics again came up for discussion and the three reforms previously mentioned were strongly insisted upon. A committee was formed, with Professor Waller, F.R.S., as chairman, with the object of comparing the clinical and physiological phenomena of anæsthesia with a view to death prevention. It was about this time that public and professional opinion began to incline towards the inclusion of local anæsthetics in any legislative measure that might be drafted, principally, no doubt, by reason of the occurrence of several cases in which threatening, and in one instance fatal symptoms had occurred after the injection of cocaine for dental operations by wholly unqualified persons.

In November, 1908, the General Medical Council expressed approval of the principle involved in the draft of the General Anæsthetics Bill, which, as above mentioned, had been submitted to the Home Secretary and referred by him to the Privy Council. It also directed its Registrar to communicate with the licensing bodies inquiring how far they had given effect to the recommendation of the Council of May 30th, 1907, with regard to its requiring evidence of instruction of students in anæsthetics. The fact that the General Medical Council was prepared to support legislation was received with great satisfaction by both the medical and the lay press throughout the country.

In December, 1908, a Departmental Committee of the Home Office was appointed by the Home Secretary to inquire into the laws relating to coroners and coroners' inquests. Subsequently the question of deaths under anæsthetics was added to the reference of this committee, and the General Anæsthetics Bill, which had been submitted to the Home Secretary and which he had, as above mentioned, referred to the Privy Council, was also referred by him to the Coroners' Committee. This committee went most minutely into the subject and examined a large number of witnesses at great length. The report eventually issued by the committee with regard to deaths under anæsthetics will be referred to subsequently.

Curiously enough a certain amount of opposition to the reform movement now began to appear from a most unexpected quarter. As the main object of the General Anæsthetics Bill was to reduce the admittedly high mortality from anæsthesia, it was naturally thought that the Bill would particularly commend itself to all those who were specially engaged in this branch of practice. When, therefore, the draft measure came before the Section of Anæsthetics of the Royal Society of Medicine on Jan. 20th, 1909, the profession was not a little perplexed to find certain leading members of that section forming themselves into a little cabal and doing all in their power to thwart the progress of reform. Public opinion, however, soon put the correct interpretation upon the opposition thus raised. Moreover, when it had been made perfectly clear to the members of the section that the General Medical Council was prepared to support the principle of the Bill, and that by adding their support they would be furthering the progress of the greater reform desired by all members of the profession—the suppression of unqualified practice in general—they voted by a considerable majority in favour of the Bill, and a resolution embodying this expression of opinion was forwarded to the Council of the Royal Society of Medicine.

In March of the same year the late Mr. George Cooper, M.P., introduced into Parliament a Bill almost identical in its scope and phraseology with the General Anæsthetics Bill. The principle involved in both Bills now became the target of attack from two quarters. The registered dentists, on the one hand, through their leading organisation, the British Dental Association, and the unregistered dentists on the other, through circulars bristling with questionable statistics, formed a temporary but united front against this principle. The former imagined that if general anæsthesia were on all occasions to be placed in the hands of the medical profession a great injustice would be done to legitimate dental practitioners; the latter saw in both draft Bills a serious menace to that exploitation of the lower classes upon which their existence depended. To conciliate the dental profession Mr. Cooper withdrew his Bill and replaced it by one which, had it ever become law, would have granted to the dental profession even greater concessions than most of its leaders were desirous of securing. His second Bill, in fact, proposed to give to dentists the right to administer not only any anæsthetic for any dental operation, but any anæsthetic for any operation whatsoever. It was now gradually becoming evident that the chief difficulty in the way of legislation lay in deciding upon the precise rôle which present and future registered dentists should be permitted to play in regard to anæsthetics. Owing to numerous circumstances, but principally to the fact that the original General Anæsthetics Bill, from which both Mr. Cooper's Bills had virtually been copied, was still under the consideration of the Home Office Departmental Committee, Mr. Cooper's second Bill was now withdrawn.

In May, 1909, Sir Donald MacAlister, in his presidential address to the General Medical Council, drew special attention to the subject of anæsthetics, and reported that practically all the examining bodies for medical qualifications had now given effect to the recommendations of the Council in regard to instruction in anæsthetics. In the same month a committee was appointed by the Council "to consider the proposals for legislation on the subject of anæsthetics which have been or may hereafter be put forward." Whilst the question was thus receiving adequate consideration at the hands of the dominant educational authority it began seriously to attract the attention of the British Dental Association. At the annual meeting of this association at Birmingham the present writer laid before that association various arguments in favour of the principle of placing all general anæsthetics, including nitrous oxide, in the hands o registered medical men, and local anæsthetics in the hands of registered medical and dental practitioners. It is to be regretted, however, that these proposals, in spite of the fac that they had the support of Mr. C. S. Tomes, Mr. William Hern, Mr. Russell Barrett, Mr. A. Hopewell-Smith, and a few other leading dentists, did not commend themselves to the dental profession as a whole. A resolution was, in fact, passed almost unanimously protesting "against any legislation which would make it illegal for registered dentists to administer anæsthetics for dental operations." It was con tended that any such legislation would not be "in the best interests of the public." In this connexion it may be mentioned that in June of the same year the Council of the Royal College of Surgeons of England decided that on and after Oct. 1st of that year all candidates for the Licence in Dental Surgery should produce a certificate "of having attended at a recognised dental hospital or school a course of practical instruction in the administration of such anæsthetics as are in common use in dental surgery"—by which phraseology they intended to exclude, as they subsequently intimated, such anæsthetics as chloroform, ether, ethyl chloride, and cocaine. Taken in conjunction with the Birmingham resolution, this decision made it clear that the dental profession intended to hold tenaciously to the right which they had for many years enjoyed of administering nitrous oxide—the anæsthetic *par excellence* in dentistry. Later on in the same year (October, 1909) the question of dentists officiating as anæsthetists was discussed from a medical point of view at the Medical Society of London. The principal object of the paper which the present writer read on that occasion[2] was to bring to a focus the various opinions which had been expressed by registered dentists and their supporters. The

[1] See THE LANCET, Jan. 30th, 1909, p. 346.

[2] THE LANCET, Oct. 30th, 1909, p. 1266.

point to be decided was to what extent registered dentists with a due regard to public safety might be permitted to produce anæsthesia. There were five possible policies. The first was that embodied in the draft General Anæsthetics Bill then before the Home Office Departmental Committee, whereby all general anæsthetics, including nitrous oxide, would be administered only by medical men and all local (injected) anæsthetics by medical men or by registered dentists. The second policy was identical with the first, except that registered dentists would be permitted to administer certain general anæsthetics (to be specified in a schedule to the Act) for dental operations. The third policy would give to registered dentists the right to administer any anæsthetic whatever for dental operations. By a fourth policy registered dentists would be permitted to administer certain scheduled anæsthetics not only in dental practice but in general surgery. By a fifth policy registered dentists would be given a perfectly free hand to administer any anæsthetic whatever for any operation, whether in dental or in general surgical practice. In deciding which of these policies would, in the public interest, be the most suitable, it was specially pointed out in the course of the paper that the very important question of the propriety of single-handed anæsthetising and operating was an integral part of the larger question before the profession—that of the form or forms of general anæsthesia to be allocated to registered dentists. There was incontrovertible evidence that in nearly every fatality that had arisen under a general anæsthetic in dental practice the operator had himself administered the anæsthetic. It was evident that if by the second policy dentists were to be permitted to administer nitrous oxide for dental operations the practice of single-handed anæsthetising and operating which was already prevalent would not only be condoned but might even increase. One distinguished authority on anæsthetics supported this second policy, although he was unable before the departmental committee to explain how it could be carried into effect without incurring the risks of single-handed anæsthetising and operating, which risks he had himself previously condemned. To extricate himself from the dilemma which he had himself created he had recourse to the statement that in the country most dentists had partners, by which he implied that they would thus be able to anæsthetise for one another. The paper read before the Medical Society of London conclusively disproved this statement as to partnerships amongst dentists, and the supporters of the second policy had therefore to fall back upon the hard fact that as about 70 per cent. of provincial dentists practise single-handed they must, therefore, in the case of a general anæsthetic either (1) administer it themselves and then operate; (2) have it administered for them by a domestic servant or some equally unskilled person; or (3) call in the services of a medical man. Unfortunately, as already indicated, the dental profession had objected to the embodiment of the first of the five policies in any legislative enactment. It was therefore clear that if the second policy were to be chosen some special regulation would have to be introduced to secure the public against these single-handed risks. As we shall see below, very definite pronouncements against single-handed anæsthetising and operating were subsequently made both by the Home Office Departmental Committee and by the General Medical Council.

On Nov. 27th, 1909, the General Medical Council adopted a report of its ANÆSTHETICS Committee. In this major report appears a minor report of the Education Committee of the Council to the effect "that the requirements of the licensing bodies with regard to instruction in anæsthetics should include (1) 'attendance on lectures and demonstrations; (2) the practical administration of anæsthetics under the supervision of recognised teachers or the members of the staff of a recognised hospital.'" After fully considering the various proposals for legislation that had up to that time been put forward, and particularly the late Mr. George Cooper's second Bill, the Anæsthetics Committee formulated certain important conclusions of which the following may be quoted:—

1. That the statutory powers with regard to medical education exercised by the Council, and in the case of need exercisable by the Privy Council, are sufficient to secure that candidates for medical or dental qualifications shall have received adequate practical instruction in the administration of anæsthetics, and that the Council has already taken steps, and is prepared to take further steps, to secure the end in view.
2. That it is inexpedient to provide by Act of Parliament that evidence of such instruction should be raised to the status of an "additional qualification," without which no person shall be entitled to registration.
3. That in the exercise of its statutory powers with regard to medical education the Council is enabled to take account from time to time of the advances of medical science in regard to the methods of procuring anæsthesia, and to vary its recommendations to the licensing bodies accordingly, in a manner which would not be practicable under the terms of the proposed Bill, should that pass into law.
4. That it is desirable in the public interest that the administration of anæsthetics for the purpose of inducing unconsciousness or insensibility to pain during medical, surgical, obstetrical, and dental operations or procedures should be restricted by law to duly qualified medical practitioners, due provision being made for the practical instruction of students, and for cases of emergency.
5. That having regard to existing conditions it is also desirable in the public interest that duly qualified dental practitioners should be authorised to administer certain specified anæsthetics, such as nitrous oxide gas, for the purpose of inducing unconsciousness or insensibility to pain during dental operations or procedures, due provision being made for the practical instruction of dental students.
6. That the specification of the anæsthetic substances or drugs which may thus be employed by duly qualified dental practitioners during dental operations or procedures should be made in a schedule to the proposed Act of Parliament, power being reserved to the Privy Council, on the recommendation of the General Medical Council as the authority charged with the publication of the British Pharmacopœia—to add to or vary the specified list from time to time as occasion arises.
7. That it is expedient in the public interest to provide that the person who administers the anæsthetic for the purpose of inducing unconsciousness during any medical, surgical, or dental operation or procedure, should not be the person who performs the said operation or procedure, due provision being made for cases of emergency.
10. That for the present it should be left to the licensing bodies to determine the precise form of the evidence of "adequate practical instruction in the administration of anæsthetics," which they require to be produced by candidates for their medical or dental qualifications.

There are one or two points in the foregoing Conclusions which deserve attention. The first of these is that the Council confirmed its previous pronouncement in favour of the principle of placing all anæsthetics in the hands of medical men, but, "having regard to existing conditions," is prepared to sanction the administration of certain anæsthetics by registered dentists. The second is that although local anæsthetics are not specifically referred to it is clear that the Council intended their remarks to extend to the administration of such substances. The third important point is that the Council at the time of this report certainly intended to restrict registered dentists, when acting as anæsthetists, to their own particular department of practice. The fourth point is that the Council definitely expressed disapproval of the practice of single-handed anæsthetising and operating, not only in general surgical but in dental practice.

On March 18th, 1910, the Home Office Departmental Committee, which had been appointed primarily to consider the law relating to coroners and coroners' inquests, and secondarily to inquire into "the question of deaths resulting from the administration of anæsthetics," issued its report upon the latter subject. Whilst it is unnecessary here to reproduce this valuable report *in extenso*, the two following sections may be cited:—

6. Anæsthetics are either general or local. Dealing first with the general respirable anæsthetics, the administration of which produces complete unconsciousness, and always involves a possible risk to life, we strongly urge that it should be made a criminal offence for any person to administer them who has not professional qualifications, or is not acting under the personal supervision of a person so qualified. We consider that the public ought to have the guarantee of professional training, and the further guarantee afforded by the administrator belonging to a recognised profession, with a high sense of responsibility, and under the disciplinary control of the General Medical Council.

8. One point we desire to emphasise. We have had evidence that many of the accidents which have occurred in connexion with the use of nitrous oxide gas occurred when the same person both administered the gas and performed the operation. We think that in no case should one person attempt both to administer the gas and operate. If a medical man is not employed to administer the gas, the dentist should have the assistance of another practitioner for this purpose. When the patient is a woman, it is obviously important for the protection of the dentist as well as for the safety of the patient that a third person should be present. Single-handed operations under anæsthetics have given rise to several false charges of assault. This, however, is a matter which can be better dealt with by a professional by-law than by direct legislation.

The report terminates with the following recommendations:—

1. Every death under an anæsthetic should be reported to the coroner, who, after inquiry, should determine whether it is desirable to hold an inquest or not.
2. In the case of every death under an anæsthetic the medical certificate of death should specify the fact whether the anæsthetic was the actual cause of death or not.
3. No general respirable anæsthetic should be administered by any person who is not a registered medical or dental practitioner.
4. Registered dentists should be confined to the use of nitrous oxide gas for dental operations, and should not employ the general respirable anæsthetics of longer duration.

5. Intra-spinal anæsthesia should be practised only by registered medical practitioners.
6. Practical and theoretical instruction in the administration of anæsthetics should be an essential part of the medical curriculum.
7. Such instruction in the administration of nitrous oxide gas should be an essential part of the dental curriculum.
8. In the case of any death under an anæsthetic in a hospital or other similar public institution, there should be a scientific investigation into the actual cause of death conducted by the authorities of the institution.
9. A small standing scientific committee on anæsthetics should be instituted under the authority of the Home Office.

(To be continued.)

"FÖRSTER'S OPERATION" OF POSTERIOR ROOT SECTION FOR THE TREATMENT OF SPASTICITY,

WITH AN ILLUSTRATIVE CASE.

BY OTTO MAY, M.D. CANTAB., M.R.C.P. LOND.,
PHYSICIAN TO OUT-PATIENTS, EVELINA HOSPITAL FOR SICK CHILDREN, LONDON; BEIT RESEARCH FELLOW.

POSTERIOR root section is no new operation. According to Abbé,[1] the first recorded case was one performed by W. Bennett in 1888, at Horsley's suggestion, for the relief of an intractable neuralgia of the leg, which had resisted all other treatment. Since then many surgeons have performed the operation for a variety of conditions, chiefly to alleviate pain, and, more recently, to control the gastric and other crises of tabes dorsalis. To O. Förster[2] of Breslau, however, is due the credit of introducing it as a routine operation for the treatment of severe forms of spastic weakness, such as occurs especially in cases of so-called cerebral diplegia (Little's disease), old hemiplegias, &c.

Physiological and Pathological Considerations.

It is a matter of common knowledge that damage to the pyramidal or "upper motor neuron" system (short of complete destruction) results in a condition of spastic weakness, characterised by a great exaggeration of all the deep reflexes and an increase in the tonus of groups of muscles, which leads to more or less marked contractures, with consequent vicious fixation of the limb segments. To simplify the matter, I will confine my remarks for the present to the lower limbs, but the same applies, *mutatis mutandis*, to the arms.

The condition is seen, perhaps, most typically in a case of well-marked cerebral diplegia, where the legs are rigid, usually in a position of extreme adduction at the hip-joints, and a tendency to flexion at hip, knee, and ankle. The tendon-jerks are grossly exaggerated, there is a well-marked ankle-clonus, and the well-known Babinski sign is present. Further, "associated movements" are marked; any attempt to move one joint usually results in movements, not only of the other joints of that leg, but of the other leg, and not only of the other leg, but also of the trunk, the arms, and often the head and neck. Connected with this is the great increase of the "defensive flexion reflex" (Abwehrbeugreflex). Normally, if the sole is stroked fairly firmly there results a transitory slight contraction of the hip flexors, knee flexors, and dorsal flexors of the foot. In the cases under consideration this is enormously increased, so that mere contact of the sole of the foot with the ground produces such strong contractions of these muscles as to render attempts at walking quite hopeless.

These, then, are the striking phenomena associated with damage to the descending cortico-spinal tracts. There is conclusive evidence that the actual exciting cause is an exaggeration of the reflexes which normally govern muscular "tone." This "tone" is dependent on afferent impulses entering the spinal cord by its posterior roots, from the tendons, muscles, joints, ligaments, and other accessory parts of the locomotor apparatus. Our knowledge of this subject is very largely due to the researches of Sherrington,[3] who has investigated the alterations of tone of various synergic and antagonistic groups of muscles during the performance of reflex movements under normal and abnormal conditions. If in an animal transection of the brain is performed at the level of the posterior corpora quadrigemina, there supervenes the condition of "decerebrate rigidity," characterised by stiff extension of the elbows and knees. If now the posterior roots corresponding to a limb are cut the extensor spasm of that limb is immediately abolished. This influence on spasticity of afferent impulses reaching the cord by the posterior roots is confirmed clinically by numerous observations. In tabes dorsalis the supervention of a cerebral hemiplegia may fail to be followed by spasticity of the affected leg and, conversely, the development of tabes in a patient suffering from an old hemiplegia may result in the gradual disappearance of the spasticity.

The usually accepted explanation of the development of spasticity in the muscles as a result of damage to the pyramidal system is that the latter has a double function—(*a*) the conduction of excito-motor impulses from the cortex to the lower centres, and (*b*) the conduction of inhibitory impulses to these centres. It is assumed that normally impulses (*b*) control and check the reflex tonus; when the corresponding fibres are damaged this inhibitory control is weakened or lost, and the ungoverned tonus leads to the development of spastic contractures. The supporters of this theory[4] regard the fibres of function (*b*) as, on the whole, more vulnerable than those of (*a*), so that in most cases spasticity is a more marked feature than actual paralysis (*vide infra*); indeed, a considerable residue of voluntary power may largely be masked by the severity of the contractures. It may be noted in passing that Sherrington[5] has found ample experimental evidence of cortical inhibition of tonus in his work on "reciprocal innervation."

If, then, the spasticity in cases of pyramidal tract disease results from the loss of inhibitory control of the reflexly produced tonus two possible remedial methods suggest themselves: (1) reinforcement of the inhibitory mechanism, and (2) damping of the tonus mechanism. The former is at present beyond the scope of surgical therapeutics; the latter is the object of the operative treatment recommended by Förster, which consists essentially in dividing certain posterior roots, so selected as to diminish as much as possible the afferent paths for the affected groups of muscle, without producing either ataxia of their movements or anæsthesia of the skin.

The guiding principles which determine the selection of the roots to be divided in any particular case are as follows: Each muscle or group of muscles is innervated from at least *three* segments of the cord, so that division of any two consecutive roots will not completely deprive any group of its afferent innervation—i.e., will not produce ataxia. Further, Sherrington[6] showed in apes that no obvious cutaneous anæsthesia ever resulted from section of two consecutive posterior roots; at least three had to be divided to produce definite anæsthesia, a result amply confirmed in man by numerous observers. Therefore Förster[2] enunciated the principle never to divide more than two consecutive roots, and to pick these so as to include two roots from the innervation of each muscle group that it is desired to influence. In his papers[7 8] he gives the following table of innervation for the lower limb, compiled from the works of Kocher, Lazarus, Bruns, Wichmann, and Oppenheim.

Flexors of thigh	L. 1 2 3 4 5	S. 1
Ilio-psoas	L. 1 2 3	
Sartorius	,,	
Gracilis	L. 2 3 4	
Tensor fasciæ	L. (4) 5	S. 1
Extensors of thigh	L. 5	S. 1 2
Adductors ,, ...	L. 2 3 4 (5)	
Abductors ,, ...	L. 5	S. 1 2
External rotators of thigh ...	L. 5	S. 1 2
Internal ,, ,, ...	L. 3 4 5	S. 1 2
Adductor magnus (pars inf.) ...	L. 3 4	
Tensor fasciæ	L. (4) 5	S. 1
Gluteus medius and minimus ...	L. 5	S. 1 2
Extensors of leg	L. 2 3 4	
Flexors ,, ...	L. 5	S. 1 2
Dorsal flexors of foot	L. 4 5	S. 1
Plantar ,, ,, ...	L. 5	S. 1 2

Thus, for example, if the chief groups affected are the adductors and flexors of the thighs, the flexors of the leg, and the plantar flexors of the foot, division of the posterior roots of L. 2 3 5. S. 2 would influence all these groups without producing either marked anæsthesia or ataxia. These four roots are, in fact, the ones recommended by him for division in typical cases of spastic paraplegia or cerebral diplegia, though other combinations may be devised for special cases. More recently Taylor[9] has suggested dividing some of the filaments of each root, instead