CONCLUSIONS

It may be stated that hyoscine amnesia in labour has in my hands proved an entirely safe method, as regards both the mother and the child. Labour is not delayed, puerperal morbidity is not increased, and the babies are born without circulatory or respiratory defects. Amnesia is absolute, and covers a period including the whole of the second stage of labour. There have been no fatalities nor accidents attributable in any way to the hyoscine.

The only disadvantages are the need for constant supervision during the labour, and the occasional necessity for two nurses to control the patient. I do not wish to minimize this difficulty, as it is a real one, and the only serious objection to a more general use of the method. It may, however, be emphasized that restlessness occurs in less than half the cases, and is only of serious degree in a small minority—three cases in this series of fifty.

I have never adopted hyoscine amnesia in domiciliary midwifery, and would not do so unless I could be assured of the presence of the possibly necessary skilled assistants. I consider that the best results will always be obtained when one has the assistance of a nursing staff who are thoroughly acquainted with the details of the treatment. The cases in this series have been consecutive and were treated in one nursing home with a constant nursing staff.

SOME OBSERVATIONS ON THE SYMPATHETIC NERVOUS SYSTEM *

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The sympathetic nervous system and the parasympathetic make up the autonomic nervous system, with which the endocrine glands are in close association. I would, at first, like to call your attention to one or two facts which indicate that the sympathetic system is anatomically arranged to give a widespread physiological effect on stimulation, and that all its diverse activities are co-ordinated to produce in the body the response required to meet most favourably circumstances arising at any particular moment. The bilateral ganglionated cord of the sympathetic system reveals a ganglion for each segmental area of the body (except in the cervical region, where fusion has reduced the number to three); from each ganglion sympathetic fibres proper are carried to each of the spinal nerves by the grey rami for distribution to the somatic areas. The connexions of the ganglia to the cord, however (named white rami), are confined to the dorsal and upper lumbar spinal segments, and each of the fibres making up the white rami synapse with several cells in the sympathetic chain, so that a generalized body effect is produced by stimulation passing out of the cord in a comparatively restricted area. The splanchnic nerves spread their impulses widely in a similar way to the viscera. Moreover, there is a central control situated in the hypothalamic region at the base of the brain, which is, in turn, influenced to some extent by the cortex.

Woollard and Norrish (*Brit. Journ. Surg.*, 1933, xxi, 83) say: "It is to be inferred that the autonomic system as a whole appears comparatively late (in development), and of its three portions the sympathetic system (keeping this term for the thoraco-lumbar outflow) is the last of all to appear." Another feature in development which seems to run parallel with the perfecting of a sympathetic system is the independence of the organism of vagaries in its external environment. This is accomplished by a mechanism for keeping constant the internal environment in all

the many conditions which are always tending to its variation, and the co-ordination of the components of this mechanism are apparently controlled by the sympathetic system and its closely associated allies. The more urgent the demand on this mechanism the more does it seem to be controlled by the sympathetic nerves. In quiet conditions, presumably, the endocrine glands are sufficient protection, since it has been shown by Cannon that the whole of the peripheral ganglionated cords of the sympathetic system can be removed in an animal; and, provided it is not exposed to great variations in temperature or to any other condition which might demand a struggle for existence, it can live comfortably and without difficulty.

If one keeps in mind this fundamental purpose of the sympathetic nervous system it is easy to understand its apparently contradictory action on tissue of the same character: for example, stimulation by strong emotions causes constriction of the unstriated muscle of the peripheral vessels and relaxation of the unstriated muscle of the intestine and bronchioles, the object being to force blood into such important organs as the brain and the heart, to conserve energy which would otherwise be expended on intestinal activity—for the moment wastefully—and to ensure a freer supply of air to oxygenate the rapidly moving blood. Moreover, the spleen is contracted, whereby a large number of red cells are forced into the circulation to carry an increased supply of oxygen to the hyperactive tissues, where rapid oxygenation is essential; and sweating (another sympathetic function) dissipates the heat so engendered, which would quickly become dangerous if not eliminated. I want to emphasize this aspect of the sympathetic system, because surgery has become rather busy with it in recent years, and the localized nature of the operations is apt to make us rather forgetful of the generalized activities of the sympathetic, with which surgery has had little to do as yet.

The chief conditions for which operations have been performed on the sympathetic nerves can be arranged under four headings: (1) vascular; (2) secretory; (3) dysfunction of unstriated muscle of hollow viscera; and (4) certain painful conditions.

ACTION OF SYMPATHETIC NERVES ON VESSELS

The predominating effect of the sympathetic nerves is constriction of the vessels. The more unstriated muscle in the wall the more is the vessel influenced by the vaso-constrictors; consequently the large vessels are little affected, whereas the small arteries can be constricted to the point of complete closure. Section of the vaso-constrictors releases the vessel from its normal tonicity, and dilatation results. It is not known whether there are vaso-dilator fibres to the vessels; if there are, they are probably parasympathetic in origin, and take the same peripheral course as the sympathetic nerves—that is to say, run in the ordinary spinal nerves and innervate the vessels by branches distributed as they pass along the limbs. A limb deprived of its sympathetic supply becomes hot and, at first, rather red, and sweating cannot be induced by normal means. In the course of a few days the redness lessens and the extremity becomes rather paler than the normal side; this is said to be due to the capillaries regaining some tone. The blood, however, still flows more quickly, and the part remains permanently warmer than the other side.

Raynaud's Disease

This being the case it seemed reasonable to expect sympathectomy to be beneficial in conditions which are obviously due to vasospasm, the typical example being Raynaud's disease. This is a paroxysmal, bilateral vasospasm of the digital arteries provoked by cold or emotion in certain subjects, and in severe cases it goes on to

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superficial necrosis or loss of the terminal parts of the digits by a process of dry gangrene. But it soon became obvious that the vessels in Raynaud's disease do not behave in quite the same way after sympathectomy as they do in normal cases. The immediate response is the same, but if, very soon after the operation on the upper extremity, the hands be cooled for twenty minutes in water at 15° C. in a constant room temperature of 18° to 20° C. and the rest of the body be then heated to 40° C. with the dried hands lying exposed, it will be found that the surface temperature of the normal hands very quickly rises to the maximum of 32° to 34° C.; whereas in Raynaud's disease there is a longer latent period before the rise begins, though thereafter it rapidly goes on to the same extent. Six to nine months later the same experiment shows that the normal vessels respond to heating better than those in a patient with Raynaud's disease, but in neither case is the response so marked as it was just after operation. According to Lewis, Raynaud's disease depends on a local fault in the small arteries, and this explains why it is possible to induce cyanosis by immersing the hands in cold water in all cases of the disease after sympathectomy, since the operation does not cure this local defect. But why should not the limb with normal vessels respond fully to heating after it has been sympathectomized? No doubt a recovery in tone accounts for this in part, but in order to get a completely satisfying explanation it seems necessary to assume that sympathectomy interrupts dilator as well as constrictor fibres to the vessels.

Theoretically, therefore, the ultimate benefit to a patient with Raynaud's disease would appear to be doubtful; experience demonstrates, however, that such a patient actually gains a great deal. The majority of cases do not develop cyanosis after sympathectomy so easily as before; the attacks are shorter; they are not painful; the functional capacity of the digits is increased; and the liability to ulceration is removed. A small number of patients receive little or no benefit; they are found among the advanced cases with sclerodactyly and marked ulceration or gangrene—that is to say, organic changes have been superimposed on the spasm. There is a curious difference between the upper and lower limbs: in the latter the results are said to be always good, the failures being confined to the upper limb. The greater difficulty of the operation and the greater variability of sympathetic distribution in the latter case do not seem to me to be the full explanation, though it is the one usually given.

Acrocyanosis : Thrombo-angiitis Obliterans

Acrocyanosis is another disorder which reacts to sympathectomy in the same way as Raynaud's disease, and for similar reasons. The principle underlying this operation is an improvement in the blood supply, and in this respect it conforms to that of the usual medical methods—such as massage, radiant heat, counter-irritation, and so on; but, whereas the latter are intermittent and have to be repeated, sympathectomy seeks to produce its effects once and for all. The usual methods should be tried first, but it must be kept in mind that sympathectomy gives its best results in cases which have not been allowed to progress too far. Where organic obstruction to vessels is present removal of constrictor fibres can offer little or no useful prospect, and that is why the operation has had only a limited use in such diseases as thrombo-angiitis obliterans. This is a progressive disease, mainly of the lower limbs, in which the larger arteries become slowly obliterated; it is painful, and may be accompanied by intermittent claudication. The ultimate result is usually gangrene requiring amputation, but in some cases the disease is arrested spontaneously. Sympathectomy will abolish pain (except that due to claudication, which it

only lessens); but whether it will improve the blood supply can only be determined by preliminary tests—tests which should normally produce vaso-dilatation. These are heating the body, local anaesthesia of the main nerve trunks or of the appropriate sympathetic ganglia, spinal anaesthesia in the case of the lower limbs, and protein shock phenomena induced by the intravenous injection of triple typhoid vaccine. Should one or other of these tests show that no vaso-dilatation can be obtained in the affected limb, or only a rise of 2° or 3° C., the operation is contraindicated. A bigger rise in temperature affords ground for hope that sympathectomy will at least retard the disease, and, as it is usually bilateral and generally progresses to gangrene, this is a gain: but there is evidence that the value of the operation extends even to that of a curative effect. I have had little success in these cases, because they have mostly been late ones; but in two there has been no evidence of advance during twelve months since the operation.

There are many diverse conditions in which a better blood supply would be of benefit to the tissues, and if it can be shown that sympathectomy is able to effect this the operation should be considered: such are chronic ulcerations of many kinds, and recurrent chilblains and ulceration in limbs afflicted with the results of anterior poliomyelitis (I have had one very successful case of this type). There is a possibility that better knowledge of the anatomy and physiology of the sympathetic system may open up eventually a much bigger field for the operation. So far I have seen no real ill effects following limited interference with sympathetic innervation.

SYMPATHETIC NERVES AND SECRETIONS

Sympathectomy permanently abolishes sweating due to natural causes over an area which accurately delineates the sympathetic supply. This is so definitely established that it is a useful sign as to whether complete division of the sympathetic supply has been accomplished. I have had only one case of excessive sweating in which I have had the opportunity to perform the operation. This was that of a young man of 26 in the Salvation Army. The fervour generated in the course of his work caused sweat to pour down the left side of his face, the right being only normally moist. I removed the superior cervical sympathetic ganglion and his face remained perfectly dry for the time he was under my observation. This was done three years ago. I recently had a letter from him from the Sandwich Islands, to which locality he has been transferred, in which he says that the left side of his face still remains dry, and he is highly satisfied with the result.

Probably a wider application to the operation will be found in those unfortunate people—usually excitable females—who suffer intensely from moist, clammy hands and feet. The feet, particularly, in these cases become sodden, fissured, painful, and offensive: these can be relieved at once and quickly cured by sympathectomy.

DERANGED FUNCTION IN HOLLOW VISCERA

Functional derangements of the bladder, ureters, and colon are those for which sympathectomy has been most often performed. I shall confine my remarks to the colon. The action of the sympathetic system here is inhibitory, except at the sphincters, where it causes contraction; the parasympathetic system has the reverse action. It is assumed that overaction of sympathetic or diminished activity of parasympathetic nerves is responsible for certain irregularities of bowel function, and in either case sympathectomy permits more effective peristaltic efforts of the colon.

Hirschsprung's Disease

In Hirschsprung's disease no medical treatment alone is satisfactory, and hitherto effective surgical intervention

has been accompanied by too serious a risk; but in sympathectomy we have undoubtedly a safe and efficient method of attack. The bowels act from the first without enemata, whereas these were necessary before; the abdominal distension becomes much less; the general well-being is immensely improved; and by *x*-ray examination it is seen that haustrations appear in the sac-like colon, which was present before operation. The operation should be done in childhood because the hypertrophied colon gradually develops a good deal of fibrous tissue in its wall; and as in the case of the vessels, so in that of the colon, such organic change cannot be rectified by sympathectomy. Moreover, it is a mistake to think that surgery is all that is needed: there is always a tendency to relapse, which can only be prevented by re-education of the bowel muscle by careful medical attention.

Chronic Constipation

As such excellent results followed sympathectomy in Hirschsprung's disease it was perhaps natural that surgeons should have turned their attention to its effect on chronic constipation. This is a subject bristling with difficulties, and so far it is not easy to be sure of the proper place surgery should take. Hitherto many surgical procedures have had their day and passed into desuetude. Sympathectomy may share the same fate. I think it almost certainly will, when we understand better the chemical phenomena which lie at the root of unstriated muscle response. In the meantime the results as a whole are encouraging; the operation is without any greater risk than attaches to any simple intra-abdominal procedure; and the only ill effect which may occur seems to be a relapse into the pre-operative state. The main difficulty, in my opinion, is selecting the right case. The first essential is the failure of medical treatment materially to relieve the chronic ill-health which sometimes accompanies irregular and infrequent action of the bowels. The second essential is, I think, the state of the colon as revealed by *x*-ray examination: there should be some distension, absence of well-marked haustrations, and apparent increase in length of the colon. These are the signs one would expect to see with inhibition; the reverse would indicate spasticity, and would presumably not be improved by sympathectomy. In the type of case I have indicated there is no question as to the immediate results being good, even dramatic: patients who have had no action of the bowels for days, and then only with huge doses of aperients or not without enemata, begin in two or three days after operation to have the bowels moved without other artificial help; they gain in weight, improve in complexion, and later get back to work, which they may have had to give up; they also lose the abdominal discomfort, sometimes amounting to pain, which so often accompanies their pre-operative state. There is, however, a decided tendency to relapse in the course of six or twelve months; but, even so, the majority of patients are better off than before. I am sure, from my experience, that careful medical supervision after operation delays this tendency to recur; and improper selection of cases is another reason for relapse. It may be, too, that further experience of the path of sympathetic impulses will show that operative procedure can be improved.

I have performed sympathectomy on sixteen patients with chronic constipation of the kind I am describing. In answer to inquiries I have had no reply from two; in two the results have been poor, the patients having relapsed into their former condition; in two, large doses of aperients, but not enemata, are required, but both say they feel much better generally; six of the remaining ten have daily action of the bowels without any aperient,

have no abdominal pain, and feel very well. Three of these patients were operated on in 1931 and three in 1932. Here is a letter from one of the former: "I should like to say my operation was a success; my bowels work regularly from day to day, I never have any pains, and I am stronger and better in health than ever before in my life." The others write in a similar strain. Four of these ten cases have been operated on too recently to be sure of the ultimate result. There have been no fatalities.

CERTAIN PAINFUL CONDITIONS

The association of the sympathetic system with pain is confusing. As regards the viscera there is no great difficulty. Pain is caused by abnormal tension on the muscle fibres in the hollow viscera, and probably by stretching of the fibrous capsule in the case of the solid organs. The only afferent pathway from the viscera is via the sympathetic nerves, though the ultimate entrance into the central nervous system is supposed to be by the posterior spinal roots. Sympathectomy, therefore, must interrupt the afferent fibres. But in the case of the limbs it is different. The sympathetic fibres run in the ordinary somatic nerves, not as separate trunks, as in the case of the splanchnics; and if they enter the spinal cord through the posterior roots, as they are said to do, there is no means of interrupting them apart from section of the peripheral nerve trunks. Nevertheless, sympathetic ganglionectomy, which does not interfere with these trunks, undoubtedly abolishes certain types of pain in the limbs. The pain which can be so influenced is of the ill-defined, rather widespread, and usually burning type, which Head called *protopathic*, and which seems to arise—sometimes at any rate—in the walls of the vessels. Sympathectomy, therefore, may abolish pain indirectly by an efferent effect, having nothing to do with the afferent impulses—or our supposition that the afferent fibres pass directly by the posterior roots, avoiding the sympathetic ganglia, may be wrong. There is a third possibility—namely, that pain fibres pass up the network of nerves which surround the vessels, in which case they would ultimately reach the sympathetic ganglia. The most dependable evidence favours the first view. It is assumed that the pain experienced in Raynaud's disease is caused by spasm of the small arteries, or by the collection of irritating metabolites in the capillary areas beyond the spasm; in either case sympathectomy should, and does, relieve the pain by causing vasodilatation.

Causalgia

I have had five cases of *causalgia* in which the patient has been instantly relieved of the excruciating pain experienced before sympathectomy, and probably for the same reason as applies to the cases of Raynaud's disease. Whatever the real explanation, this method of treatment is so effective that it should entirely displace the crippling operation of median or ulnar nerve excision, which is carried out by some surgeons with the object of intercepting the pain fibres, and in the hope that, when regeneration ultimately occurs, the pain will not return.

The paroxysmal attacks of pain so characteristic of trigeminal neuralgia suggest very strongly what one notices in *causalgia*, and it was for this reason that I removed the right stellate ganglion in an elderly woman suffering from a severe manifestation of this complaint. This was done eighteen months ago, and was followed by instant relief of pain: on inquiry during the last fortnight her doctor tells me she has had no return of it, and he considers her cured. The dangers of injury of important structures at operation are as nothing compared to those associated with direct attacks on the Gasserian ganglion or its roots, and if further experience substantiates its effectiveness this procedure will be a very distinct gain.