Discussion

Sir LUDWIG GUTTMANN (*G.B.*). I would like to ask the speakers, as they have not mentioned it, whether the muscles were paralysed due to a lower motor neuron lesion, a combined upper and lower motor neuron lesion or an upper motor neuron lesion. As you know, in L1 and T12 lesions, we very often have a lower motor neuron lesion in the lower limbs and it would be important to know whether these patients have been classified accordingly. It is also important to know whether an electrical examination of the paralysed muscles was carried out. In relationship to blood flow, I remind you of the experimental studies accomplished in the 30's and 40's on the effect of electrical exercise on paralysed muscles due to peripheral nerve lesions. They have quite definitely disproved the old concept introduced in 1915 by Langley, a famous physiologist in England, that electrical exercise of denervated muscles has no effect. In fact, there were many clinicians who felt electrical exercise in lower motor lesions to be harmful, but from my clinical and experimental experiences I could never subscribe to this idea. At the beginning of the Second World War I had the opportunity to investigate this problem, with the co-operation of Ernst Gutmann, a Czechoslavakian colleague, experimentally on rabbits. Our results were published in 1941 and 1943. There is no doubt whatsoever that proper electrical exercise used as a substitute for active exercise to the peripherally paralysed muscle, has important beneficial effects in (*a*) delaying the atrophy of paralysed muscles by promoting better metabolic conditions as a result of better vascularnisation and (*b*) encouraging recovery in muscles not completely paralysed. Workers who investigated the peripheral metabolism of the peripherally paralysed muscles and blood flow have confirmed these findings. At the Peripheral Nerve Centre set up during the war at Oxford under Professor Seddon, this beneficial effect of galvanic exercise as a substitute for active exercise in peripheral nerve or root lesions has been confirmed in many paralysed people. I would like to ask Dr. Seifert or Dr. Lob whether they investigated the patients electrically before they did their very interesting experiments on blood flow.

The other paper in which I was very interested was that of the Stoke Mandeville Group of workers. This is a new approach to getting statistics on hypertension and we, as many other people, are just beginning to find the value of computer medicine. However, I do not think for a moment that the computer approach will replace clinical observations and good doctoring.

Dr. SEIFERT (*Germany*). I thank Sir Ludwig Guttmann for his advice. We did not check electrically the muscles nor did we check as to whether the paralysis was due to peripheral neuron or the upper neuron lesions, this must be done in another group of investigations. This was the first group with only eight patients involved and, of course, we will do more investigations.

P. HARRIS (*G.B.*). Regarding Dr. Seifert's paper I would like to ask one question: he and his colleagues have done this interesting work on the blood flow in muscles of paraplegics and mention the probable or possible importance in relation to pressure ulcers. I wonder about the possible correlation between the blood flow in muscles and in the skin—the cutaneous blood flow. Have they studied this aspect of the situation ?

Dr. J. SEIFERT (*Germany*). We did not study the blood flow of skin, we studied blood flow of muscles.

Professor M. WEISS (*Poland*). I am happy to report that in my research group we have implanted electrodes and are using continuous electrical stimulation together with similar studies. We have found not only improvement and continuous keeping of a good capillary flow, thanks to the stimulation, but also the growing up of muscle belly and now it is possible to use techniques other than the simple galvanic current since we are collaborating with engineers who can adjust for us a complete automatic system. For instance, in our group of tetraplegics where electrical stimulation is applied hourly with the aid of a special automatic watch, which includes testing simultaneously the current and control of the effect on the muscles is checked by EMG.

We have also observed with the Lublyana group the effect of electrical exercise on hemiplegics and we now want to examine early cases with lower motor lesions simultaneously. This will be done by implanting small electrodes in the peroneal region and by using surface electrodes.

CHAIRMAN. There is a group in one of the United States Naval Hospitals working on the problem of latent hypo-volumia. The purpose of this is to explain the fairly consistent and persistent low B.P. in tetraplegic patients which have been found early after injury. In some patients with injuries resulting from the Vietnam War they have found that these occur also with severe and extensive orthopaedic injuries even without involvement of the central nervous system. As a matter of fact I am soliciting a report on this subject for the next year's meeting. In my own little contribution to this which Dr. Michaelis was kind enough to mention, my interest was in relating hypertension to renal changes. I assume and hope that your statistical studies will include that in the fullness of time. Sir Ludwig, did you have another remark ?

Sir LUDWIG GUTTMANN (*G.B.*). I would like to make a few points concerning the interesting remarks of Professor Weiss from Konstancin in Polland. With regard to the electrical stimulation in paralysed people I mentioned first of all those of the lower motor neuron. This applies to both cauda equina lesions and root lesions in tetraplegics. And I agree with Professor Weiss that in cases of this kind, forms of electric current other than galvanism can be used to obtain powerful contractions of the denervated muscles—in fact this has always been done at Stoke Mandeville. This is especially important in tetraplegics, if the important triceps muscle and the extensors of the wrist are only partly paralysed it is at this time when we should stimulate the muscles, if active exercise by the patient cannot be carried out. There has, on occasions, been the objection of fatiguing the paralysed or weak muscles. This I think you can forget. I have made extensive studies of this and found that if the paralysed muscle is over-fatigued by too many powerful electrical stimulations it will recover after a short time of rest, but you will prevent or delay atrophy in these patients and preserve good contractibility of the muscles. The other important point is the effect of electrical stimulation on the afferent system. In my paper on spinal shock and reflex behaviour I mentioned the experience of old neurologists. They described that the absent knee and ankle jerks in the spinal shock can reappear by electrical stimulation. This has been taken up by modern physiologists who have emphasised—in particular the school of Eccles—the important role played by afferent system in the return of reflexes.

Finally, one point of warning. To treat people with motor paralysis in upper motor neuron lesion electrically is contra-indicated, because once the spinal cord has regained its automatic function the electrical stimulation is of course a very strong stimulus—indeed the strongest stimulus to increase the spasticity rather than to decrease it. I wanted to make this point in order not to confuse the issue.

Dr. F. W. MEINECKE (*Germany*). Sir Ludwig mentioned some time ago that hypertension in paraplegics may develop independently from renal causes. Has Dr. Michaelis some statistics about the percentage of non-renal hypotension in paraplegics ?

Closing remarks by essayists

Dr. L. S. MICHAELIS (*G.B.*). Dr. Meinecke will understand that I am not just evading his question when I ask him to be patient with us. This paper I read is the embryo of the paper I wanted to read but we did not get the birth finished before this meeting. I think that the research, with the help of the computer, which of course is no replacement of treatment but simply a time-saving technical aid, should continue until we come to precise results fixed to level and completeness of lesions which can be related between normal B.P. of tetraplegics, paraplegics of various levels and the general population. This may take a few years to come about, but at least at that time we shall be able to talk sensibly about the subject.