

risk. Ion-exchange resins may be useful but the electrolyte pattern must be watched. Mercurial diuretics must never be given. Acetazolamide and chlorothiazide are contraindicated. Extra potassium is usually needed. Antibiotics should always be combined with steroid therapy. The latter has not fulfilled all the hope placed in it. The mechanism of action of steroids is still mysterious; the most important action is a reduction in proteinuria. The latter is more constantly obtained in children, and it does not matter whether ACTH or cortisone is used. However, relapse is common and the long-term prognosis has not been really modified by steroid treatment. Statistics show that the number of cures after steroid treatment does not exceed 20 to 30%, and this figure is obtainable without steroids. Results of long-term treatment with steroids are also equivocal, though cure is more readily obtained in cases treated early.

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THE LATE EFFECTS OF SPINAL POLIOMYELITIS\*

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THE VARIOUS TYPES of deformities and disabilities resulting from spinal poliomyelitis are well known, and much has been written on many aspects of this problem. However, there are only a few reports<sup>1-4</sup> in the medical literature pertinent to prognosis with respect to functional recovery and to the extent of the rehabilitation problem in poliomyelitis.

The study reported here is an attempt to assess these factors in a selected group of patients included in the 3326 cases recorded in the Manitoba epidemics of 1952-53. Follow-up studies were made on this group over a period of two years and more.

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METHODS OF STUDY

It was considered impracticable to follow up all the cases in the epidemics; therefore, only poliomyelitis cases admitted in the early stages of the disease to the Winnipeg Municipal Hospitals were included in this study.

There were 1361 patients admitted to these institutions; 972 of these had spinal paralysis, while only 568 of these met the criterion of follow-up for a period of at least two years.

The 568 cases were followed up for at least two years, and many for three and four years, through hospital records, questionnaires, enquiries to personal doctors, and records of patients attending clinics designed for the follow-up of poliomyelitis patients. Records were kept of:

1. The extent and distribution of the paralysis.
2. The presence and types of deformities.
3. Splints, braces, wheel chairs, corsets, etc.
4. The number and types of operations performed.
5. Functional status as shown by the achievement of the activities of daily living, and in education or occupation.

6. Those who had to change their occupation, and those who required retraining.

As poliomyelitis is so variable, all cases were arbitrarily divided into "mild", "moderate" and "severe" categories, depending on the extent and severity of the paralysis at the time of discharge from hospital. Patients were placed in the "mild" group when they showed residual paralysis of no functional importance. The "moderate" group includes those in whom paralysis was limited to one limb, or who had a scattered paralysis not considered likely to produce any serious disability or deformity. The "severe" group includes those with paralysis so severe and extensive that significant disability was considered to be inevitable.

Disability and socio-economic assessment in children are based on ability to look after personal needs, to keep up with other children in games and sports, and to attend school. Consideration is also given to the circumstances under which children are able to attend school. The difference in assessment, and the belief that deformities are more apt to progress in a growing child, are the reasons why children 15 years of age and younger are categorized separately from adults.

TABLE I.—DEGREE OF PARALYSIS

Age group	Mild	Moderate	Severe	Total
15 years of age and under....	49	149	139	337
Adults.....	14	36	181	231
Total.....				568

RESULTS

1. *The Extent and Distribution of Paralysis*

Records of the extent and distribution of paralysis were kept, and wherever possible, power of muscles was graded on muscle charts at intervals during follow-up. This information is used as the basis for classification in Table I.

2. *The Number and Types of Deformities*

The number of deformities is shown in Table II, and the types are recorded in Table III.

TABLE II.—NUMBER OF DEFORMITIES

Age group	Mild	Moderate	Severe	Total
15 years of age and under....	7	55	113	175
Adults.....	0	2	63	65
Total.....				240

TABLE III.—TYPES OF DEFORMITIES

Type of deformity	15 years and under	Adults	Total
Scoliosis.....	95	11	106
Leg length discrepancy.....	66	4	70
Contractures e.g. equinus deformity, tight iliotibial band, etc.....	56	19	75
Other deformities e.g. genu valgum, tibial torsion, etc.....	84	40	124
More than one deformity.....	84	8	92

In no person over 15 years of age was a discrepancy in leg length disabling. None of the cases of scoliosis which occurred after 15 years of age have progressed to require surgery or external support.

Further analysis of the age incidence of scoliosis in children is shown in Table IV.

TABLE IV.—SCOLIOSIS

Age in years	No. cases of scoliosis	Total No. cases in this age group
0 - 1.....	4	11
1 - 5.....	27	136
6 - 15.....	64	189

3. *Braces and Appliances*

Two hundred and ten patients were fitted with leg braces as detailed in Table V. Fifty-two patients were fitted with appliances for the upper limb. The abduction "aeroplane" splint was used in two cases, in one for only a short time. The majority of splints for the upper limbs were for hand involvement, mainly for opponens paralysis. Two cases in which both arms were virtually flail were fitted with functional appliances of the

TABLE V.—LEG BRACES

	Mild		Moderate		Severe	
	15 and under	Adults	15 and under	Adults	15 and under	Adults
<i>One leg braced</i>						
Number.....	1	0	20	4	42	36
No. patients who discarded brace.....	1	0	10	3	23*	30
No. patients who discarded brace after operation.....	0	0	5	0	9	5
<i>Both legs braced</i>						
Number.....	0	0	3	0	49	56
No. patients who discarded braces.....	0	0	1	0	8†	24‡
No. patients who discarded braces after operation.....	0	0	0	0	3	4§

\*One patient discarded an "above knee" brace and is now wearing a "below knee" brace.

†Two patients discarded one brace only.

‡Nine patients discarded one brace, and two discarded both "above knee" braces and are now wearing one "below knee" brace.

§In one case, only one brace was discarded after operation.

“Robbins aid” type with marked benefit to one patient. Many cases with extensive involvement of both arms were fitted with balanced “feeders”—these are of immense functional value to practically all. These appliances have made it possible for most of these patients to feed themselves and they have been of great help in other functions such as writing. Wheel chairs were provided for 147 patients; 76 of these no longer use them. Corsets were provided for 109 patients; some were provided for instability of the trunk but the majority are used to provide support to the paralyzed abdominal wall.

The category designated as “restricted in some activities” includes in children those who are unable to partake of, or are restricted in the playing of games; in adults, it includes those who are unable to partake of sports in which they participated before they had poliomyelitis, those whose activities apart from their work are restricted, and those who are restricted in their occupation. The category “help required to carry on restricted activities” includes persons who require special transportation to work or special arrangements at the place of work, and also housewives able to do some of their housework but still requiring outside help for things

TABLE VI.—SURGICAL PROCEDURES

Category	No. of patients having operation	Scoliosis	Foot	Upper limb	Other	Total No. operations
Moderate.....	24	3	25	0	7	35
Severe.....	68	17	62	7	26	105
Totals.....	92	20	87	7	33	140

4. The Number and Type of Operations Performed

The 140 operations performed on 92 patients for correction of deformities included tendon lengthening, tendon transfers, joint stabilization, osteotomies, release of contractures, epiphysiodeses, and correction and fusion of the spine for scoliosis. They are outlined in Table VI.

5. Functional Status

The severity, site and distribution of residual paralysis in some measure will determine how activities of daily living are affected, such as feeding, dressing, toilet routine, walking. Cases are classified in Table VII under one of three groups.

TABLE VII.—FUNCTIONAL STATUS

Category of functional status	Mild	Moderate	Severe	Total
Group I.....	63	184	230	477
Group II.....	0	1	48	49
Group III.....	0	0	42	42

Group I—All activities of daily living can be carried out without help.

Group II—Attendant help is required to assist the patient in carrying out some of his activities.

Group III—The patient is completely helpless, requiring full-time care.

The capacity of adults to undertake work and to partake of sports or hobbies, and of children to carry on at school under varying circumstances, and their ability to play games, were recorded and are detailed in Table VIII, in four categories. These categories range from ability to carry on with full activities at one end of the scale to inability to partake of any of these activities.

they are unable to do. With respect to children, this group includes those who cannot get to school on their own, those who require special arrangements in the classroom at school, and those who are unable to get to school but are able to do their school work at home.

Rehabilitation

Special functional training, e.g. in feeding, dressing and walking, was given to 96 patients; 68 of these are now functionally independent; 40 patients found it necessary to change employment because of their paralysis; 15 of these are doing only part-time work.

Vocational training was given to 33 patients, 19 of whom are now fully employed. Six patients were unable to return to work even after vocational training; the remaining eight have not yet been placed.

DISCUSSION

Extent of Paralysis

Maximum paralysis was obvious in most cases during the initial hospital stay. A few patients discharged as non-paralytic after a short hospital stay were found to have some degree of paralysis when examined four weeks after discharge. This illustrates that medical surveillance up to one or two months is important in apparent non-paralytic poliomyelitis.

Although 60% of the patients in this study were 15 years of age or less, the adults were more severely involved; 78% of the cases in persons over 15 years old were “severe” compared with 24% in the younger age group.

Approximately 75% of deformities occurred in children. Muscle imbalance and contractures are more likely to cause disability in the growing child.

It is not surprising that these occurred in the more severely involved patients.

Scoliosis is one of the most serious deformities resulting from poliomyelitis in children. Only 20 of the 106 cases in this study were treated surgically. This does not give a true picture, as many parents refused surgical treatment for their children. It is difficult to convince parents that during the periods of active growth, scoliosis may lead to increasing disability from deformity and subsequent respiratory complications.

Out of the 140 operative procedures carried out on 92 patients, the greatest number (87) were done to improve function of the foot.

Although muscle recovery is unimportant after four to six months, functional recovery may continue for a much longer time.<sup>1, 6</sup> On this account 87% of the patients in this study eventually achieved complete independence for their own physical care. Seventy-three per cent were able to return to school or gainful employment. Many of these patients still have extensive paralysis.

TABLE VIII.—STATUS OF ACTIVITIES

Category	Mild		Moderate		Severe	
	15 and under	Adult	15 and under	Adult	15 and under	Adult
Full activity.....	49	14	138	35	82	98
Restricted in some activities.....	0	0	11	1	44	33
With help, able to carry on restricted activities..	0	0	0	0	3	10
None of these activities possible.....	0	0	0	0	10	40

#### BRACES AND APPLIANCES

A large proportion of the moderately and severely paralyzed cases required some form of brace or appliance. Ninety-eight lower-limb braces were subsequently discarded, 26 after operation and the remainder on account of muscle improvement. Some braces were discarded prematurely by the patient in the belief that paralyzed muscles do not recover fully while the limb is braced. This has not been our experience. Unfortunately this practice in children often leads to further deformity, and we are inclined to retain braces on children until growth has ceased, in order to minimize deformity.

A number of patients discarded braces because walking rehabilitation had been unsuccessful and they are now reconciled to wheel-chair existence. Some patients such as these have retained their braces to allow them to stand. This is encouraged as much as possible because it is believed that the physical effort this demands may have a beneficial effect on nitrogen balance and bone metabolism as well as kidney drainage.

Some patients who originally used wheel chairs discarded them after successful walking re-education. Through adequate functional training, wheel-chair patients may never become independent in the activities of daily living but can often resume full employment.

Some of the children in Table V with bilateral braces had involvement in one leg only. Their braces were joined to allow them to walk with crutches.

It is not the purpose of this report to give full details of surgical techniques. It is of interest that of approximately 50 cases of opponens paralysis only two had an operation. Although some of the others might have benefited by operation, the patients were satisfied with the function of their hands.

It is of interest that about 32% of cases required an initial hospital stay of six months or more. Twenty-eight patients are still in hospital, in some cases because of severe residual respiratory paralysis and in others because socio-economic problems have up to now prevented their being looked after in their homes. Eleven patients still requiring artificial respiration are on a home-care program.<sup>5</sup>

#### SUMMARY AND CONCLUSION

A follow-up study of 568 cases of spinal poliomyelitis, over at least two years and in many cases three or four years, is presented. Age incidence, types of deformities, incidence of deformities, incidence of surgery and that of bracing are discussed, and assessment of functional recovery is also attempted in an effort to show the magnitude of the problem.

The prolonged surveillance, treatment and socio-economic adjustment necessary are factors which require organization of considerable magnitude.

It is impossible to estimate the cost of constant aftercare in poliomyelitis, but it is apparent from the over-all picture that this is much greater than the effort required during the acute stage. Muscle recovery is almost always incomplete but, in spite of this, approximately 80% of the patients in this study have made excellent functional recovery, and this justifies the investment.

We thank Dr. J. Hildes, our colleague; Dr. J. Alcock, medical director, Municipal Hospitals; and Dr. C. C. Ferguson, professor of surgery, University of Manitoba, for their help. We are also grateful to many practitioners, to the Society for Crippled Children and Adults of Manitoba, and to the Children's Hospital for information from their records.

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## RÉSUMÉ

Les séquelles paralytiques de la poliomyélite furent étudiées dans un groupe choisi tiré de 3326 cas de l'épidémie du Manitoba (1952-53). Le choix porta sur les 568 malades admis aux hôpitaux municipaux de Winnipeg à la phase initiale de la maladie; ils furent ensuite suivis pendant une période s'étendant de deux à quatre ans. Les différents tableaux dans le texte donnent la répartition de l'âge, le genre et la fréquence des déformations, la fréquence des interventions chirurgicales, la répartition de l'emploi d'attelles et de prothèses et enfin l'évaluation du rétablis-

ment en vue de la fonction. La surveillance prolongée de ces cas, le traitement et l'adaptation socio-économique demandent une organisation de grande envergure. Il est impossible d'évaluer le coût des soins de post-cure dans la poliomyélite mais il est évident d'après la vue d'ensemble que présente le tableau clinique qu'il est beaucoup plus élevé que l'effort exigé dans la phase aiguë. Le rétablissement musculaire est toujours incomplet mais cependant environ 80% des malades de cette série ont obtenu un rétablissement fonctionnel excellent qui justifie l'attention qu'on leur a portée.

## THE CLINICAL RESPONSE AND THE AMOUNT OF INSULIN EXTRACTABLE FROM THE PANCREAS IN DIABETIC PATIENTS TREATED WITH ORAL HYPOGLYCÆMIC DRUGS A REPORT ON FIVE CASES\*

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### INTRODUCTION

THE PATTERN of variations in the amount of insulin extractable from the pancreas with age at diagnosis and duration of diabetes mellitus in man has been found to be generally similar to observed patterns of success and failure of treatment of diabetes using oral carbutamide (BZ-55) and tolbutamide (Orinase).<sup>1, 2</sup> When compared with values for nondiabetic controls, both the amount of extractable insulin in the pancreas and the rate of fall of blood sugar level after oral carbutamide or tolbutamide are below normal in the average diabetic human subjects.<sup>3, 4</sup> Both values decrease towards zero in a matter of months following the onset of diabetes in children (growth-onset diabetes) and remain low in such cases even after the period of normal bodily growth is passed.<sup>3, 5, 6</sup> Both values are much higher on the average in persons diagnosed as diabetic after the age of normal skeletal growth is passed (maturity-onset diabetes), and these higher values are still to be found many years after the diagnosis of diabetes.<sup>3, 7</sup>

The very low values of extractable insulin in growth-onset diabetes and also in some cases of maturity-onset diabetes are associated with the absence or gross depletion of demonstrable beta cells in the pancreas.<sup>5</sup> These represent cases of diabetes mellitus caused by or at least associated with a lack of endogenous insulin secretion. Such patients require injected insulin in order to survive.

It would appear from the above indirect comparisons that the action of carbutamide and tol-

butamide in lowering the blood sugar in diabetic patients is dependent in some way, not yet elucidated, on the presence of a source of endogenous insulin. Other factors may also influence the response to therapy with the above drugs. The still poorly understood problem of resistance to insulin, both endogenous and exogenous, is probably an important factor.

Comparisons of the above type between different groups of diabetic patients are less informative than when the comparison is made in the same patient, or in numbers of such patients. The objective in this paper is to initiate such direct comparisons. The clinical and laboratory findings in five male patients with maturity-onset diabetes who were treated with insulin and with carbutamide, tolbutamide, or Glipasol,\* and in whom the amount of insulin extractable from the pancreas was subsequently measured at autopsy, will be considered.

The clinical studies were carried out at Shaughnessy Hospital, Vancouver, B.C., while the extractions and assays of the pancreas for insulin were performed at the Charles H. Best Institute in Toronto after shipment there by air express of the deep-frozen pancreatic tissue. Insulin was extracted by the ethanol-HCl method as described by Scott and Fisher,<sup>8</sup> and the assays were made by a mouse-convulsion method.<sup>9</sup>

CASE 1.—D.W., a 78-year-old retired plumber, was admitted to Shaughnessy Hospital in April 1949, with a history of generalized weakness for one year and polydipsia and polyuria for six months. He weighed 206 lb. (68½ inches tall). Blood pressure was 160/90 mm. Hg. Other findings on physical examination included narrowing of the retinal arterioles, slight cardiac enlargement and the absence of pulsation below the popliteal arteries. The fasting blood sugar was 293 mg. %, non-protein nitrogen (N.P.N.) 39 mg. %. Twenty units of protamine zinc and 15 units of regular insulin controlled his blood sugar levels. When seen on February 27, 1953, he weighed 189 lb., and had been taking the same insulin dosage but had not been adhering to a diet.

On March 21, 1953, he was admitted to hospital, when a fasting blood sugar was found to be 286 mg. %

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\*Glipasol: 2-sulfamido-p-aminobenzene-5-terbutyl-1-thia-3,4-diazole. Poulenc Limited, Montreal.