BRITISH MEDICAL JOURNAL

LONDON SATURDAY MARCH 31 1962

NEUROLOGICAL AND OPHTHALMIC DISORDERS IN CHILDREN OF VERY LOW BIRTH WEIGHT

A SURVEY WITH THE SOCIETY OF MEDICAL OFFICERS OF HEALTH

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The Medical Research Council in an investigation of oxygen therapy and retrolental fibroplasia studied over a thousand infants weighing not more than 4 lb. (1,800 g.) at birth (Report, 1955). The sample comprised all infants of this weight born between October 1, 1951, and May 31, 1953, and admitted to one of the 19* premature-baby units participating in the survey. A questionary was completed for each infant which included antenatal particulars and details of labour, delivery, the infant's condition in the early weeks of life, oxygen therapy, and other treatment given. This sample of children of very low birth weight was regarded as suitable for a study of the relationship between characteristics and events before and around the time of birth and neurological and ophthalmic disorders evident later. The prevalence of these disorders found in a survey of the children is described in this first report.

Method

The subjects of the survey, which was started in March, 1959, were all the children originally studied by the Medical Research Council who had survived to the age of 6 months; they numbered 1,128. Principal school medical officers arranged for school health visitors to complete for each child a standard questionary designed to detect nervous, visual, and hearing disorders. The health visitor was asked to inquire from the mother the age at which the child first walked unsupported and made small sentences, and about any history of convulsions, and from the teacher about the child's progress at school. She was also asked to see the child and to note any abnormality of gait, manual dexterity, speech, vision, and hearing.

If the health visitor recorded any evidence of disorder reports were sought from specialists, school medical officers, and general practitioners. In an attempt to avoid missing minor degrees of cerebral palsy I examined two groups of children: those reported not to have walked alone until after their second birthday, and those in whom any abnormality of gait or manual dexterity had been noted. Furthermore, in order to study the clinical features of cerebral palsy in the sample, I examined as many as possible of the children found with or suspected to have this disorder.

Letters were sent, if an address was obtainable, to the parents of children who had emigrated asking similar questions to those included in the health visitors' questionary. If information could not be obtained from the parents, inquiries were made from relatives, and existing records were consulted. Reports on children who had died were sought from hospitals.

Of the 1,128 children originally investigated by the Medical Research Council all but 19 were traced (Table I). Some information was available about three of the untraced children; one had emigrated at the age of 3 years and was reported at the time to be puny, flat-footed, and not to have walked or talked until after her third birthday. Another, whose parents were gypsies, was admitted to a children's hospital at the age of 16 months and was then thought to be blind, spastic, and mentally retarded. A third was adopted but was said to be healthy at the age of 2 years. No useful information was available about the remaining 16 children, of whom one was the son of an American soldier, three were known to have been adopted, and six had changed their name.

TABLE I.—*Tracing of Children and Their Survival*

City	No. of Children Alive at Age of 6 Months	Untraced	Traced	
			Died	Survived
Belfast	95	0	2	93
Birmingham ..	205	5	5	195
Bristol	100	0	1	99
Cardiff	90	0	0	90
Edinburgh ..	44	1	1	42
Glasgow	32	1	2	29
Leeds	42	0	0	42
Liverpool ..	216	4	8	204
London	89	5	3	81
Manchester ..	70	2	2	66
Newcastle	34	0	0	34
Oxford	42	0	2	40
Sheffield	35	0	1	34
Southend	34	1	1	32
Total ..	1,128	19	28	1,081

Twenty-eight children were found to have died between the ages of 6 months and 6 years (Table I) and particulars of the cause of death were obtained. Information was received as follows about 15 children who had emigrated: five were described by their parents as normal, and relatives had recently heard that two other children were healthy and developing normally; there were good indications in records that a further five children were normal at 3 and 4 years of age, and that another was walking and talking normally at 18 months; a mild degree of cerebral palsy was described in the school health record of one child and in the hospital notes of another.

Health visitors completed a questionary for each of the remaining 1,066 children. Further reports were obtained as already indicated and clinical examinations

*The report on the M.R.C. Survey was based on 17 of the 19 premature-baby units in which the investigation was undertaken.

were made of 121 children, including 35 of the 71 children found to have cerebral palsy.

As a check on children reported by health visitors to have walked before their second birthday and to have no abnormality of gait or manual dexterity a clinical examination was made of 14 such children admitted to the survey in Southend and still living in the county borough. On neurological examination 13 of them were regarded as normal and one was found to have minor abnormal signs (diminished ability to perform rapid movements with the right foot, non-sustained right ankle clonus, and a right extensor plantar response).

Prevalence of Neurological and Ophthalmic Disorders in Children Who Died

The quality of the clinical accounts of the 28 children who died and the amount of detail available varied considerably, but neurological disorders were reported in 15 (54%). Three children, of whom one had spastic "paraplegia," were hydrocephalic. Three children were developing normally until the age of 1 or 2 years but succumbed to an illness diagnosed as encephalitis or status epilepticus. One child developed a leucodystrophy. Eight children were said to have been mentally retarded or spastic or both. In two of these a definite diagnosis of cerebral palsy—spastic hemiplegia and spastic diplegia—was made, four more were probably spastic, and five of the eight suffered from fits.

Of the 13 children without reported neurological disorders nine were said to have died from infections, including one with tuberculous meningitis and one with pyogenic meningitis. Two children died from trauma, one from reticulosis, and one, whose mother had had rubella in early pregnancy, from congenital heart disease.

Three of the children who died were said to have retrolental fibroplasia, and the child mentioned above whose mother had had rubella had cataracts.

Prevalence of Neurological and Ophthalmic Disorders in Surviving Children

Evidence of a neurological or severe ophthalmic disorder was found in 244 (22.6%) of the 1,081 surviving children who were traced (Table II). There were 71 (6.6%) children with cerebral palsy, 29 (2.7%) mentally retarded to an ineducable degree, 102 (9.4%) with a history of one or more fits, 24 (2.2%) with other neurological disorders, 20 (1.9%) who were blind from retrolental fibroplasia, 35 (3.2%) who had severe visual defects (retrolental fibroplasia, cataracts, nystagmus), and 19 (1.8%) who were moderately or severely deaf. The prevalence of cerebral palsy was found to be remarkably constant from city to city, and there were no marked differences in the prevalence of mental retardation, history of fits, and deafness. There were, however, apparent differences in the prevalence of retrolental fibroplasia. The number of cases expected and observed in the two cities with the largest number of children and the remaining cities is shown in Table III. The actual probability that these differences arose by chance must, however, be considered rather more than 0.002, as cities with a low and a high prevalence were selected.

TABLE III

	No. of Surviving Children Traced	Retrolental Fibroplasia (Blind or Severe Visual Defect)	
		Expected	Observed
Birmingham ..	195	7·2	0
Liverpool ..	204	7·5	14
Other cities ..	682	25·2	26

$\chi^2 = 12{\cdot}8$, 2 d.f.; $P < 0{\cdot}002$.

Cerebral Palsy

Cerebral palsy was defined as a non-progressive motor disorder of cerebral origin evident before the age of 2 years, excluding cases secondary to an obvious lesion. There were 71 (6.6%) children in whom this diagnosis was made. Nearly all had started to walk late, although one child in eight was walking alone before the age of 2 years (Table IV). Two-fifths of the children were still not walking unaided at the time of the survey—that is, when they were from 6 to 8 years old. One-third were attending ordinary schools; most of the others attended special day or residential schools, and a few were in hospitals.

Thirteen (18%) children had a history of one or more fits (Table V). Nine (13%) children were considered ineducable. Only 2 (3%) of the 71 children had retrolental fibroplasia resulting in a serious visual defect.

TABLE II.—*Prevalence of Neurological and Ophthalmic Disorders According to City of Birth. Number of Children and Rate per Hundred Children Traced*

Disorder	Belfast (93)	Birmingham (195)	Bristol (99)	Cardiff (90)	Edinburgh (42)	Glasgow (29)	Leeds (42)	Liverpool (204)	London (81)	Manchester (66)	Newcastle (34)	Oxford (40)	Sheffield (34)	Southend (32)	Total (1,081)
Cerebral palsy ..	5 *5·4*	15 *7·7*	9 *9·1*	5 *5·6*	2 *4·8*	1 *3·4*	3 *7·1*	14 *6·9*	5 *6·2*	3 *4·5*	1 *2·9*	3 *7·5*	3 *8·8*	2 *6·3*	71 *6·6*
Mental retardation (ineducable) ..	2 *2·2*	3 *1·5*	5 *5·1*	3 *3·3*	1 *2·3*	0 *0*	2 *4·8*	7 *3·4*	1 *1·2*	2 *3·0*	0 *0*	0 *0*	1 *2·9*	2 *6·3*	29 *2·7*
Fits: (1) 1 or more fit at 3 years or over or 3 or more episodes at under 3 years	4 *4·3*	18 *9·2*	4 *4·0*	9 *10·0*	0 *0*	4 *13·8*	1 *2·4*	10 *4·9*	3 *3·7*	1 *1·5*	1 *2·9*	4 *10·0*	1 *2·9*	2 *6·3*	62 *5·7*
(2) Fewer than 3 episodes at under 3 years	2 *2·2*	7 *3·6*	1 *1·0*	3 *3·3*	0 *0*	0 *0*	2 *4·8*	13 *6·4*	3 *3·7*	5 *7·6*	2 *5·9*	1 *2·5*	1 *2·9*	0 *0*	40 *3·7*
Other neurological disorders ..	2 *2·2*	3 *1·5*	1 *1·0*	5 *5·6*	2 *4·8*	1 *3·4*	2 *4·8*	4 *2·0*	0 *0*	1 *1·5*	1 *2·9*	0 *0*	1 *2·9*	1 *3·1*	24 *2·2*
Retrolental fibroplasia:															
Blind	4 *4·3*	0 *0*	0 *0*	3 *3·3*	0 *0*	1 *3·4*	0 *0*	10 *4·9*	0 *0*	0 *0*	0 *0*	0 *0*	1 *2·9*	1 *3·1*	20 *1·9*
Severe defect ..	2 *2·2*	0 *0*	2 *2·0*	4 *4·4*	0 *0*	0 *0*	1 *2·4*	4 *2·0*	3 *3·7*	2 *3·0*	0 *0*	0 *0*	1 *3·1*	1 *3·1*	20 *1·9*
Cataract	0 *0*	3 *1·5*	3 *3·0*	0 *0*	0 *0*	0 *0*	1 *2·4*	1 *0·5*	0 *0*	1 *1·5*	0 *0*	0 *0*	1 *2·9*	1 *3·1*	11 *1·0*
Blindness from other causes ..	1 *1·1*	1 *0·5*	0 *0*	0 *0*	0 *0*	0 *0*	0 *0*	1 *0·5*	0 *0*	0 *0*	0 *0*	0 *0*	1 *2·9*	0 *0*	4 *0·4*
Severe nystagmus	0 *0*	0 *0*	0 *0*	1 *1·1*	0 *0*	0 *0*	1 *2·4*	0 *0*	0 *0*	2 *3·0*	0 *0*	0 *0*	0 *0*	0 *0*	4 *0·4*
Deafness of moderate or severe degree	2 *2·2*	5 *2·6*	4 *4·0*	2 *2·2*	0 *0*	0 *0*	0 *0*	2 *1·0*	0 *0*	1 *1·5*	2 *5·9*	0 *0*	1 *2·9*	0 *0*	19 *1·8*
Total No. of children with a disorder	20 *21·5*	40 *20·5*	21 *21·2*	26 *28·9*	5 *11·9*	6 *20·7*	9 *21·4*	54 *26·5*	14 *17·3*	16 *24·2*	7 *20·1*	8 *20*	11 *32·4*	7 *21·9*	244 *22·6*

Over a third had squints (Table VI). Two (40%) of the five children with bilateral athetosis were deaf, but only one (1.5%) of the 66 children with other clinical types of cerebral palsy was found to be substantially deaf.

TABLE IV.—*Education and Ability to Walk by Clinical Type of Cerebral Palsy*

	Spastic								All Types
	Diplegia with Upper Limbs Affected			Monoplegia	Hemiplegia	Double Hemiplegia	Bilateral Athetosis	Other and Mixed Types	
	Not Appreciably	Mildly	Moderately						
No. in group..	27*† (38%)	10 (14%)	11 (15%)	6 (8%)	5 (7%)	3 (4%)	5 (7%)	4 (6%)	71 (100%)
Not walking alone ..	2	6	11	0	0	3	3	4	29 (40%)
Walked alone before 2 years	4	0	0	3	2	0	0	0	9 (13%)
Ineducable ..	0	0	4	0	0	3	0	2	9 (13%)
Attending: Ordinary school ..	16	0	0	3	4	0	2	0	25 (35%)
Special school	9	10	7	3	1	0	3	2	35 (49%)

* Education not known in two cases. † Walking not known in one case.

TABLE V.—*Association of Various Neurological and Ophthalmic Disorders*

Disorder	No. of Children	Percentage with Associated Disorder					
		Cerebral Palsy	Mental Retardation	History of Fits	Deafness	Retrolental Fibroplasia	Cataract
Cerebral palsy ..	71		**12·7**	18·3	4·2	2·8	2·8
Mental retardation	29	31·0		**27·6**	0	**20·7**	10·3
History of fits*..	102	12·7	**7·8**		2·0	2·0	3·9
Deafness ..	19	15·8	0	10·5		5·3	0
Retrolental fibroplasia	40	5·0	**15·0**	5·0	2·5		0
Cataract.. ..	11	18·2	27·3	36·4	0	0	
Total No. of children	1,081	6·6	2·7	9·4	1·8	3·8	1·0

Figures in bold type: difference ÷ standard error ≥ 2. *One or more fits.

TABLE VI.—*Clinical Types of Cerebral Palsy and Associated Disorders*

Associated Disorders*	Spastic								All Types
	Diplegia with Upper Limbs Affected			Monoplegia	Hemiplegia	Double Hemiplegia	Bilateral Athetosis	Other and Mixed Types	
	Not Appreciably	Mildly	Moderately						
	27	10	11	6	5	3	5	4	71 (100%)
Visual defects: Retrolental fibroplasia	1	0	1	0	0	0	0	0	2 (3%)
Cataract ..	0	0	0	1	0	1	0	0	2 (3%)
Squint ..	10	7	5	0	2	1	1	1	27 (38%)
Deafness ..	0	0	0	1	0	0	2	0	3 (4%)
Fits (1) ..	2	1	3	0	2	0	0	1	9 (13%)
Fits (2) ..	2	0	0	0	0	0	1	1	4 (6%)

Spastic diplegia—that is, bilateral spasticity affecting lower more than upper limbs—was found in 48 (68%) children. In 27 there was a fairly symmetrical spasticity of both lower limbs with little appreciable involvement of the upper limbs—a clinical syndrome sometimes referred to as "paraplegia." Over half the children in whom this diagnosis was made were attending ordinary schools (Table IV). In 10 children the upper limbs were slightly and often asymmetrically affected and in 11 they were moderately or severely affected but always less so than the lower limbs.

Six (8%) children had a spastic monoplegia, in all cases of a lower limb; five were on the left side and one was on the right. There were 5 (7%) children with a spastic hemiplegia. In two of them the upper limb was more affected than the lower, in one child the upper and lower limbs appeared to be equally involved, and in the other two the lower limb was more affected than the upper limb. Three (4%) children had "double hemiplegia" with spasticity of all four limbs, the upper more than the lower; two of them were microcephalic and all three severely mentally retarded.

Five (7%) children had bilateral athetosis, two being mildly and three severely affected. There were four children who could not be assigned to any of the above categories: three showed spasticity—two with ataxia and one with athetosis—and one child had a variable rigidity with mental defect.

Mental Retardation

Twenty-nine (2.7%) children were estimated to have an intelligence quotient of not more than 50. The assessment of children with gross motor disorder was difficult, but where any doubt existed—for example, in the case of a child with severe bilateral athetosis—the child was not classed as ineducable. Severe deafness caused a similar complication, and although doubt existed in two cases no deaf child was classed as ineducable. Nine of the 29 children considered ineducable had cerebral palsy and another three had mongolism. Ten of the 17 children without cerebral palsy or mongolism had little or no sight: six were virtually blind with retrolental fibroplasia, three had bilateral cataracts, and one was microcephalic and was thought to have blindness of cortical origin.

A history of fits was commoner among mentally retarded children, with and without cerebral palsy, than among children with an estimated intelligence quotient of above 50. None of the nine ineducable children with cerebral palsy was walking alone at the time of the survey; all three children with mongolism were walking; and all but 2 of the 17 remaining children were walking unaided.

History of Fits

Children with a history of fits were divided into two group. The first, in which the risk of further fits was thought to be greater than in the other group, comprised children who had had either three or more separate episodes of fits at any age or at least one fit at the age of 3 years or over. The children in the second group had had not more than two separate episodes of fits and were less than 3 years old when they occurred.

Of the 62 (5.7%) children with a history of one or more fits at 3 years or over, or three or more episodes at under 3 years, 10 (16%) had cerebral palsy and a further three were regarded as ineducable but had no motor disorder. The remaining 49 children had few other disorders—one had retrolental fibroplasia and one was deaf—but 11 (22%) had not walked alone until they were at least 2 years old, compared with 6% of all the children in the sample excluding those with cerebral palsy and those regarded as ineducable (difference ÷ standard error = 16 ÷ 6 = 2.7).

Forty children (3.7% of the surviving children traced) had had fewer than three episodes of fits at under the age of 3 years. Six of them had cerebral palsy or mental defect and none had any other disorder. Four (12%) of the 34 children without cerebral palsy or mental defect first walked alone after their second birthday, but this excess was not significant at a 5% level.

Other Neurological Disorders

In the 24 children coming under this category the following clinical conditions occurred:

	Number of children
Astrocytoma of brain stem	1
Amyotonia congenita (familial)	1
Hydrocephalus with left crural monoplegia	1
Residual monoplegia from poliomyelitis	2
Facial palsy (mild—dating from birth)	1
Möbius syndrome	1
Dyslexia	1
Slight deafness following meningitis	1
Motor retardation and clumsiness	11
Minor abnormal neurological signs	4

A diagnosis of motor retardation was made in 11 children judged to have a motor performance well below the level expected at their age. One child had an extensor plantar response in one foot; the other 10 had no evidence of paresis, spasticity, dystonia, involuntary movements, or sensory disturbance.

Minor abnormal neurological signs were elicited in four children not judged to be significantly retarded in general motor development. In three children there was a slight crural monoplegia: rapid movements of the foot were not executed as well as on the other side, and clonus and an extensor plantar response were elicited. In one child there was a bilateral extensor plantar response without other abnormal signs.

Deafness

Nineteen children had perceptive deafness of a moderate or severe degree. Of the 19, two had bilateral athetosis, one had spastic monoplegia, one had retrolental fibroplasia, and two had a history of fits. The 16 deaf children without cerebral palsy tended to walk late; four (25%) did not walk alone until after their second birthday, compared with 6% in the whole sample (difference ÷ standard error = 19 ÷ 10.9 = 1.7).

Ophthalmic Disorders

Forty children (3.7%) were left with severely impaired sight after retrolental fibroplasia in infancy. Twenty (1.9%) were virtually blind and 20 (1.9%) had a marked loss of vision, often blindness of one eye. No association with cerebral palsy, fits, or deafness was found, but 6 of the 20 blind children were regarded as ineducable.

Eleven (1%) of the surviving children were found to have cataracts. Three of these had severe epilepsy and were ineducable. One child was regarded as ineducable but had no history of fits, and two more had a history of fits at 3 years or over.

Three of the four children who were blind or virtually blind from causes other than retrolental fibroplasia or cataract were mentally defective, and the blindness was thought to be of cortical origin; the remaining child had optic atrophy.

Four children had nystagmus of unknown cause which seriously interfered with their vision. One of the children had a history of fits and in three there was delayed motor development.

Discussion

It is not easy to estimate the extent to which the methods of case-finding were successful. It is certainly not justifiable to assume that the 14 children examined in Southend were representative of all those passed by health visitors as normal, but the fact that one of these children was found to have a slight motor disorder suggests that similar cases may have been missed. Any disability resulting from this degree of cerebral palsy would be trivial; there was no complaint by the mother of the child who was seen. Since the ultimate purpose of the study was to compare pre-natal and natal factors in children with and without disorders, failure to detect all abnormal children would be likely to prejudice the results only in the direction of diminishing any positive findings.

The prevalence of cerebral palsy among surviving children included in this survey was found to be 6.6%, whereas among children of all birth weights it is generally estimated at between 0.2% and 0.4%. In a study of the health in early pregnancy of over 3,000 women in relation to congenital defects in their children, a survey of the children when they were from 3 to 6 years old (McDonald, 1961), using methods similar to those employed in the present survey, yielded a prevalence of cerebral palsy of 0.3% (Table VII). Cerebral palsy occurs more often in children of very low birth weight. Ingram and Kerr (1954) made a minimal estimate of 4.5% in children weighing not more than 4 lb. (1,800 g.) at birth. Drillien (1961a), who followed 50 children weighing not more than 3 lb. (1,360 g.) from birth to the age of at least 5 years, found 6 (12%) with cerebral palsy. In the present survey the prevalence in children of this birth weight was approximately 10%.

TABLE VII.—*Prevalence of Neurological and Ophthalmic Disorders Compared with a Sample of Children of all Birth Weights*

Disorder	Birth Weight up to 4lb. (1,800 g.) (1,081)		All Birth Weights (McDonald, 1961) (2,906)	
	No. of Children	Prevalence %	No. of Children	Prevalence %
Cerebral palsy	71	6·6	8	0·3
Mental retardation (ineducable)	29	2·7	16	0·6
Cataract	11	1·0	1	0·03
Retrolental fibroplasia	40	3·7	0	0
Perceptive deafness of moderate or severe degree	19	1·8	1	0·03

The diagnosis of mental retardation is particularly difficult in children with defects of sight, hearing, or movement, and in those who have been emotionally deprived, because these handicaps may restrict their intellectual activity and development, and certainly affect methods of assessment. For these reasons any comparison of the total prevalence of 2.7% of mental retardation which was found in this survey is of limited value. However, it may be noted that in this series the prevalence of mental retardation in the absence of cerebral palsy or severe visual or hearing disorder was less than 1%. The observation that half the ineducable children without associated motor disorder or mongolism had little or no sight arouses the suspicion that inability to learn through visual means may have contributed to their mental retardation.

It is not easy to evaluate the significance of a history of fits. Many children who have fits in infancy,

particularly those precipitated by fever, appear to suffer no adverse effects in later life, whereas many adults with epilepsy do not start to have fits until puberty. However, among the children with a history of fits, especially those occurring after the first two years of life, there are undoubtedly some who will continue to have fits.

In all, 9.4% of the children in the survey had a history of one or more fits. Exclusion of all children with cerebral palsy or mental retardation on the grounds that fits tend to be associated with these disorders, reduces the figure to 7.7%. Even so, this is higher than the prevalence generally found. In Newcastle upon Tyne, in a careful study of 847 children from birth to the age of 5 years (Miller *et al.*, 1960), 5.8% were found to have had one or more convulsions during this period. In a rather less detailed study in Edinburgh (Drillien, 1961b) the proportion was 4.9%, and in a survey of children in Watford (McDonald, 1961) 4% of those aged 5 years were found to have such a history. The methods used in the present survey were most comparable with those used in the Watford survey. Thus the proportion of children with a history of fits is probably about twice that found in children of all birth weights.

There was some evidence that children without cerebral palsy or mental defect who had a history of fits differed from those without such a history in that they more often failed to walk alone before the age of 2 years. Intellectual inferiority could perhaps account for this observation, and it is hoped later to examine this question.

Most of the cases of severe deafness were probably detected, but deafness even of a degree sufficient to interfere with education may well have been missed, and mild degrees of deafness were certainly not detected, as no routine audiometry was undertaken. Two children were found during the course of inquiries in connexion with the survey to be deaf enough to require education in special schools. Although the prevalence found of 1.8% is probably an underestimate, the prevalence of perceptive deafness is clearly higher in children of very low birth weight than in heavier children. Only one case was found in 2,906 children of all birth weights (McDonald, 1961). Drillien (1961a) found a total of 6 (12%) children with defective hearing in a sample of 50 children weighing up to 3 lb. (1,360 g.). In the comparable weight group in the present series the prevalence was only 3%; however, the degree of deafness may have been greater than in Drillien's sample.

Nearly 4% of the children were found to be left with severely damaged sight as a result of retrolental fibroplasia. This may be an underestimate, because, although visual defects were simple to detect, it was difficult to discover whether retrolental fibroplasia contributed to myopia, particularly in unilateral cases. The prevalence of cataracts is undoubtedly higher in children of very low birth weight than in heavier children; 1% of children in this survey had cataracts, compared with one in 2,906 children of all birth weights (McDonald, 1961). The cataracts appeared to be associated with fits, mental retardation, and cerebral palsy, although the actual number of children involved was very small, and tests of significance were negative.

No comparable estimates are available of the relative proportions of different clinical types of cerebral palsy in children of all birth weights. In surveys which have been made of cases known to hospitals and local authorities children with minor degrees of cerebral palsy are more likely to have been omitted than in the present survey. Another difficulty in comparing surveys is that cases may be classified differently. However, in most of the series described roughly one-third of the individuals have hemiplegia, rather more than a third are bilaterally spastic, and the remainder have athetoid or other less frequent types of cerebral palsy. In this series there were only 5 (7%) children with hemiplegia, and three of them had unusual clinical features in that there was a tendency for the lower limb to be at least as much affected as the upper. Spastic diplegia is known to be associated with very low birth weight. Crural monoplegia may be regarded as belonging to the same syndrome. If to the high proportion of diplegias in this series are added the monoplegias and the three hemiplegias of crural type the diplegic syndrome accounts for 80% of the cerebral palsy in the sample.

Evidence of an association between retrolental fibroplasia and cerebral palsy was presented by Ingram and Kerr (1954), but there is clear evidence that in the present series there was none. The children with retrolental fibroplasia had an average incidence of all disorders except for a high proportion of them found to be ineducable, upon which comment has already been made.

Cerebral palsy, mental defect, and fits are known to be commonly associated. Because mental defect and fits are less frequent in spastic diplegia than in other types of cerebral palsy the incidence of both these conditions in children with cerebral palsy was low.

Summary

A survey was undertaken of 1,128 children aged 6 to 8 years whose birth weight was not more than 4 lb. (1,800 g.). The sample comprised all infants of this weight admitted to 19 premature-baby units in 14 cities who were born between October 1, 1951, and May 31, 1953, and who survived to the age of 6 months.

The purpose of the survey was to study the relationship between characteristics and experiences around the time of birth and neurological and ophthalmic disorders evident later; this will be the subject of later papers. The present report gives an account of the methods used in the survey, the prevalence found of neurological and ophthalmic disorders, and associations observed between these disorders.

Twenty-eight children were found to have died between the age of 6 months and 6 years; 15 (54%) were reported to have neurological disorders. All but 19 (1.6%) of the remaining 1,100 children were traced; 244 (22.6%) were found to have a neurological or ophthalmic disorder. The total prevalence of each of these disorders found among the 1,081 traced surviving children are given (Table II).

Of the 71 children with cerebral palsy, 48 (68%) had spastic diplegia. It is suggested that six cases of crural monoplegia and three of hemiplegia in which the lower limb was at least as much affected as the upper may belong to the diplegic syndrome, which would thus account for 80% of the cerebral palsy found in this series.

No association was found between cerebral palsy and retrolental fibroplasia, but one-third of the children regarded as ineducable who were not suffering from

cerebral palsy or mongolism were blind with retrolental fiboplasia.

This survey would have been impossible without the unfailing co-operation of the principal school medical officers to 91 local education authorities. Thanks are due to the Medical Research Council for permission to use their records and to the consultant paediatricians to the 19 premature-baby units for help in following up their patients.

It is a pleasure to thank all the many persons who have contributed to the survey, particularly the school health visitors for their excellent field work and the staff of the General Register Office and local executive councils for their invaluable help in tracing children.

The investigation was suggested by Professor P. E. Polani, and he has advised throughout.

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LOCATION OF STEREOTACTIC LESIONS CONFIRMED AT NECROPSY

BY

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[WITH SPECIAL PLATE]

Owing to the generous co-operation of neurosurgeons and pathologists in seven different neurosurgical units, material from the central nervous system of 15 patients who had had stereotactic operations has been received.

This paper is concerned with the gross location of the lesion made in the brains of patients who had undergone stereotactic operations. It is the first of a series of papers reporting the results of anatomo-pathological studies based on this and similar material.

Material and Methods

The entire brain from 13 patients and part of the brain from two patients were available for examination. Thirteen patients had Parkinson's disease, one had Huntington's chorea, and one had severe hemichorea. In 10 patients (11 operations) the target for the lesion was the globus pallidus, and in five patients the thalamus. The lesions were produced by the injection of chemicals or by heat. The various methods and the number of patients treated by each method are shown in Table I.

TABLE I.—*Methods of Making Lesions:* 15 *Patients* (16 *Sides*)

Chemical Coagulation				Thermo-coagulation
Injection of Absolute Alcohol	Injection of Absolute Alcohol after Dilatation of Balloon (Cooper's Method)	Injection of Etopalin (Ethyl Cellulose, "Pantopaque," and Absolute Alcohol)	Injection of Etopalin Thickened with Kaolin	Diathermy (Leksell's Method)
4 patients (5 sides): Cases 4R and L, 5, 7, 11	3 patients: Cases 2, 6, 10	1 patient: Case 12	3 patients: Cases 3, 8, 9	4 patients: Cases 1, 13, 14, 15

TABLE II.—*Four Patients in Whom Death was Not Due to Operation*

Case No.	Sex and Age	Disease	Side Operated On	Cause of Death	Survival
2	M 57	Idiopathic Parkinsonism	Right	Cellulitis of face, paraphimosis, septicaemia, pneumonia	25 days
4*	M 34	Post-encephalitic Parkinsonism	Left	Decerebrate state following second stereotactic operation	12 months after first operation; 8 months after second operation
6	F 60	Idiopathic Parkinsonism	Right	Suicide	6 months
15	F 53	Idiopathic Parkinsonism	Left	Cardiac failure	10 months

* This patient is also included in Table IV.

The cause of death is obviously of great importance when considering the location of the stereotactic lesion, for we want to know whether it can be taken as representative of the lesions made in the brains of other patients who have not yet died. If the operation causes the death of the patient, there is a strong likelihood that the lesion is in some way different from those in other patients who did not die. On the basis of

TABLE III.—*Six Patients in Whom Death was Indirectly Due to Operation*

Case No.	Sex and Age	Disease	Side Operated On	Cause of Death	Survival
9	F 56	Idiopathic Parkinsonism	Left	Pulmonary embolism	8 days
12	M 48	?Parkinsonism	,,	Pulmonary embolism	11 days
14	M 51	Idiopathic Parkinsonism	,,	Pulmonary embolism; pyelonephritis; cystitis	2½ months
10	F 40	Huntington's chorea	Right	Basal meningitis; pneumonia	15 days
1	M 67	Parkinsonism after typhoid	,,	Poor post-operative state—cachexia; pneumonia	3 months
13	M 55	Idiopathic Parkinsonism	,,	Acute pulmonary oedema	12 hours

TABLE IV.—*Six Patients in Whom Death was Directly Due to Operation*

Case No.	Sex and Age	Disease	Side Operated On	Cause of Death	Survival
5	F 65	Idiopathic Parkinsonism	Right	Never recovered from injections of procaine into second globus pallidus. Pneumonia	20 days after first injection
11	F 69	Uncontrollable hemichorea	,,	Never recovered from operation; pneumonia	4 days
8	M 43	Post-encephalitic Parkinsonism	,,	Hemiballismus; exhaustion	11 days
3	M 68	,, ,,	Left	Severe hemiparesis; pseudobulbar palsy	4½ months
4*	M 34	,, ,,	Right	Intracerebral haemorrhage occurring at operation; decerebrate state following operation	8 months
7	M 49	Parkinsonism	Left	Intracerebral haemorrhage following operation	7 days

* This case is also included in Table II.