A NEUROBEHAVIORAL SYNDROME AFTER FAILURE TO THRIVE ON CHLORIDE-DEFICIENT FORMULA

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From March 1978 to August 1979, Neo-Mull-Soy (NMS) and CHO-Free, two soy-based infant formulas marketed in the United States, were grossly chloride-deficient, but otherwise adequate in electrolytes and other nutrients. A similarly chloride-deficient formula was marketed in Spain under the name Aptamil-1 (Rodriguez-Soriano *et al.* 1983). Infants maintained on these formulas developed a syndrome marked by loss of appetite, failure to gain weight, muscular weakness, lethargy, vomiting and severe hypochloremic, hypokalemic metabolic alkalosis (Grossman *et al.* 1980, Wolfsdorf and Senior 1980). Urinary chloride was markedly decreased or absent (Roy and Arant 1981, Rodriguez-Soriano *et al.* 1983). Almost all infants had a decelerated linear growth, weight-gain and head circumference (Roy and Arant 1981). Although the clinical features resembled those of Bartter syndrome, renal biopsy was normal, and within a few days of dietary chloride supplementation the infants became normokalemic, their acute symptoms resolved and catch-up growth occurred (Grossman *et al.* 1980, Roy 1984).

Since then, several follow-up studies have tried to ascertain what, if any, cognitive residua resulted from exposure to these chloride-deficient formulas. Evaluations of 10 of the exposed infants, conducted four to five years later when they were still of preschool age, found them to have average intelligence, but three were considered to have behavior patterns that could interfere with school performance (Hellerstein *et al.* 1985).

Other preliminary follow-up reports also suggested developmental delay (Chutorian *et al.* 1985, Willoughby *et al.* 1987). Willoughby and colleagues, studying two- and four-year-old children who had been exposed to a chloride-deficient formula during infancy, found a negative dose-response relationship between exclusive use of the formula and cognitive abilities, as measured by the Bayley Scales of Infant Development, as well as perceptual motor and fine motor abilities, as measured by the McCarthy scales. Approximately three years after their diagnosis, a cohort of Spanish children exposed to a chloride-deficient formula were said to have normal mean intelligence, but a 50 per cent incidence of language disabilities (Rodriguez-Soriano, personal communication). A more recent population-based study matched first- and second-grade children who had been exposed to chloride-deficient soy formula during infancy with children who had received other soy formulas. The experimental group scored significantly less well on the General Cognitive Index of the McCarthy scales, and specifically

TABLE I
Summary of growth parameters

	Sex	Growth before NMS* (centile)			Start of NMS		Time on NMS (mths)	Lowest point on NMS (centile)			Formula after NMS	Last follow-up	
		Wt	L	HC	Reason	Age (mths)		Wt	L	HC**		Age (yrs)	HC (centile)
1	M	88	88	82	Congestion, rash	1·0	8·0	<78	<72	<64	Isomil + table foods	8·2	38
2	M	92	86	82	Eczema, allergy, diarrhea	1·0	7·5	<90	<36	<81	Unknown	5·5	24
3	M	58	88	88	Mild emesis	Birth	3·5	<57	<81	<46	Enfamil	5·2	54
4	M	84	95	>99	Rash, ?milk allergy	2·0	4·0	<68	<16	<1	Enfamil + meat, vegetables	5·5	90
5	F	62	27	54	Colic, diarrhea	2·0	4·0	<55	0	<46	2% milk, fruit	6·7	5
6	M	62	69	24	Colic	4·0	5·0	<41	<7	<16	Isomil + baby foods	7·5	31
7	M	84	86	69	Colic, fussiness	1·0	7·0	<15	<44	<23	Nursoy + solid foods	6·6	8
8	M	27	4	12	Rhinorrhea, vomiting	3·0	3·5	<26	<3	<9	Unknown	10·0	21
9	M	31	69	82	Vomiting, stomach ache, constipation	4·5	5·5	<30	<15	<78	Baby foods	9·8	2
10	F	21	24	62	Colic	2·5	9·5	<18	<23	<61	Milk	8·8	1
11	M	1	4	4	Rash	1·0	8·5	<1	<3	<20	KCl, aspirin, cereal, fruit	6·3	5
12	F	96	84	79	Regurgitation, ?milk allergy	1·0	4·5	<69	<76	<75	Isomil + baby foods	6·2	18
13	M	92	54	69	Milk intolerance	2·5	6·5	<61	<40	<21	All foods	9·6	84

*NMS = Neo-Mull-Soy: chloride-deficient infant feeding formula.
**Wt = weight; L = length; HC = head circumference.

on the quantitative subscores (Willoughby *et al.* 1990).

Of a sample of 13 children who during infancy developed symptoms of hypokalemic, hypochloremic metabolic alkalosis and/or growth deceleration concurrently with their exposure to chloride-deficient NMS, 11 children had a distinctive constellation of cognitive and motor deficits, but preserved general intellectual functioning. In this report we detail their cognitive deficits, and present longitudinal data on four of the children.

Patients and method

Children and growth patterns

All the children were brought to our attention because their parents were concerned about a potential relationship between their child's developmental disabilities and exposure to chloride-deficient NMS.

The following information was required for retrospective diagnosis of clinically significant adverse NMS effects in the 13 children included in the study: (1) documented NMS ingestion during 1978 and 1979, the period when the formula was chloride-deficient; (2) normal gestation, delivery and neonatal period; and (3) adequate measurements of weight, length and head circumference taken before, during and after exposure to the chloride-deficient formula.

Medical and psychological records documented each child's personal, medical and family history. For four children (cases 2, 3, 8 and 11), serum electrolyte levels obtained while on NMS confirmed the clinical diagnosis of hypokalemic, hypochloremic metabolic alkalosis. For one other child (case 4), the diagnosis was supported by reduced urinary chloride.

Growth information for these 13 children is summarized in Table I, and for two typical cases, one of whom was chemically documented, in Figure 1. Duration of exposure to the chloride-deficient formula ranged from 3·5 to 9·5 (mean 5·9) months. Measurements of weight, length and head circumference for each child before chloride-deficient NMS ingestion were converted to standard (Z)

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TABLE II
Summary of neurological neurobehavioral data

	Social class	*EEG abnormal*	*Hyperreflexia*	*Hypotonia*	*Fine motor*	*Withdrawal*	*Distractability*	*Attention*	*Repetitive movements*
1	1	+			+	+	+	+	+
2	2			+		+	+	+	+
3	4		+			+	+	+	+
4	2	+	+		+	+	+	+	+
5	4			+	+		+	+	
6	3				+	+	+	+	+
7	4					+	+	+	
8	4					+	+	+	
9	4	+			+	+	+	+	+
10	6	+			+	+	+	+	+
11	3	+					+	+	
12	3						+	+	
13	4	+		+		+	+	+	+

scores, using normative data (World Health Organization 1983, Roche *et al.* 1987). The measurements immediately before starting NMS and at the low-point during ingestion are presented in Table I. Decline was computed by subtracting the low-point from the pre-ingestive value for each set of serial measurements. Follow-up measurements of head circumference were obtained either from medical records or by examination (J.H.M. or M.K.).

Family histories for 11 of the 13 children were negative for pertinent neurological or psychological conditions. Patient 2 has a brother with a mild speech abnormality and patient 5 has a brother with a history of mild reading difficulty. Before being examined by us, all 13 children had received special education, including placement in private schools or restrictive classrooms and/or various combinations of language therapy, psychotherapy/counselling, physical and occupational therapy, and individual tutoring. The socio-economic status of each family was classified according to the seven occupational categories defined by Hollingshead (1971).

Neurological examination and neuro-diagnostic studies

Neurological examinations were conducted on all the children. An EEG was obtained for 12 children (Table II). Computerized tomographic (CT) electroencephalography mapping studies were performed on two children (cases 1 and 5). CT was performed on one child (case 4) and magnetic resonance imaging (MRI) on two children (cases 4 and 9) as part of the follow-up evaluation.

Neuropsychological examinations

Twelve of the 13 children were examined with multiple standardized tests that measure intelligence, language, perception and motor co-ordination. The remaining child (case 10) was severely mentally retarded and could not vocalize, though she could walk and perform limited self-care.

TEST DESCRIPTIONS

General intelligence tests. Wechsler Preschool and Primary Scales of Intelligence (WPPSI) (Wechsler 1967); the Stanford-Binet (S-B) Intelligence Scale (Terman and Merrill 1973); the Wechsler Intelligence Scale for Children-Revised (WISC-R) (Wechsler 1974).

Language tests. (1) Receptive vocabulary (Peabody Picture Vocabulary Test) (Dunn and Dunn 1981). The test consists of 150 picture plates, each one with four pictures. At each trial the child points to the picture that corresponds to the name spoken by the examiner. Points for passed

TABLE IIIa
Summary of neuropsychological data

	Age at exam. (yrs:mths)	*IQ*	*VIQ**	*PIQ**	*PPVT-R (SS)†*	*Token Test part V/(Z)*	*Articulation*
1	4:2	101[a]					Abnormal
	5:3	110[a]			107	−1·5	Abnormal
	5:8	105[b]			105	−1·8	Abnormal
2	5:5	108[b]				−0·1	Abnormal
3	5:1	110[b]				Unable	Abnormal
4	5:5	77[b]				Unable	Abnormal
	6:9	87[c]	86	90	99	−1·7	Abnormal
	9:3	98[c]	101	95	104	−1·4	Abnormal
5	6:1	93[c]	82	108	81	−1·0	Abnormal
6	7:7	103[c]	109	92	95	−1·5	Abnormal
7	7:6	89[c]	96	85	84	−2·1	Abnormal
8	8:4	91[c]	79	108	88	−1·2	Abnormal
9	8:9	100[c]	98	101	112	−1·3	Abnormal
10	9:7	Unable	Unable	Unable	Unable	Unable	No vocalization
11	7:3	105[c]	107	104			
	9:2	100[c]	92	109	111	−0·1	Abnormal
12	6:2	102[b]				−0·5	Abnormal
13	8:10				BN	BN	Abnormal
	10:0	49[b]			BN	BN	Abnormal

*Verbal IQ; performance IQ.
[a]WPPS1; [b]Stanford-Binet; [c]WISC-R.
†Peabody Picture Vocabulary Test (standard score).
BN = below norms.

items are scored. (2) Auditory comprehension (Token Test for Children) (DiSimoni 1978). 20 tokens (chips) in two shapes (circle and square), two sizes (large and small) and five colors are displayed. The child touches (parts 1 to 4) or manipulates (part 5) tokens specified orally by the examiner in commands of graduated lengths and complexity. (3) Naming (Boston Naming Test) (Goodglass and Kaplan 1983). 60 line-drawings are presented in descending order of familiarity of name. When the child fails to identify one, the examiner gives a stimulus cue (*e.g.* category), then if still necessary, a phonemic cue (*e.g.* first phoneme). (4) Verbal fluency. (*a*) Rapid naming: Rapid Automatized Naming Test (RAN) (Denckla and Rudel 1974). Four subtests (letters, digits, colors, objects) are administered. Each subtest consists of a chart bearing 50 stimuli: 10 repetitions each of five stimuli within the category, in random sequence. Naming latency is recorded. (*b*) Name generating: Word Fluency Tests (Spreen and Gaddes 1969, Semel-Mintz and Wing 1982). In 60 seconds, children say as many words as they can beginning in turn with F, A and S, or name as many animals and foods as they can. (*c*) Sentence memory (Sentence Repetition Test) (Carmichael and MacDonald 1984). Children repeat 14 sentences, varying in length from three to 24 syllables.

Non-language test. Beery Developmental Test of Visuomotor Integration (VMI) (Beery and Buktenica 1977). Selection of the tests was based on preliminary experience which suggested that though NMS-exposed children retain general intelligence levels within the normal range, they suffer selective difficulties in language and visuomotor areas. Language impairment is not global, therefore it was necessary to evaluate separately the children's ability to comprehend and remember verbal information, and to achieve accurate and fluent verbal expression.

TABLE IIIb
Summary of neuropsychological data

	Boston naming (SD)	*N phon. cue*[1]	*RAN*[2] *(SD) N errors*	*Sentence repetition (SD)*	*Word fluency*[3]	*VMI (SD)*	*Motor co-ord.*
1	−0·6	8			A+F: normal	−0·7	Abnormal
2	−1·1	3			A+F: normal	−1·0	Abnormal
3	−1·8	3			A+F: normal	−1·3	Abnormal
4	−1·5	4			A+F: normal	−2·3	Abnormal
	−0·2	4	L=(−1·2) 4; N=(−0·8) 3; C=(−0·1) 1; 0=(−0·7) 2	−1·6	A+F: normal	−1·3	Abnormal
	−0·7	6	L=(−0·4) 0; N=(−0·2) 0; C=(−0·3) 1; 0=(−2·1) 7	−1·8	FAS: abnormal	−0·7	Abnormal
5	−2·2	7	L=(−4·4) 10; N=(−2·7) 5; C=(−2·7) 0; 0=(−1·7) 2	−1·5	A+F: normal	−1·0	Abnormal
6	−2·2	8	L=(−2·1) 1; N=(−1·9) 3; C=(−0·7) 2; 0=(−2·3) 7	−0·8		−1·3	Abnormal
7	−1·4	3	L=(−4·6) 1; N=(−2·5) 1; C=(−2·5) 1; 0=(+0·1) 0	−1·1	A+F: normal	−2·0	Abnormal
8	−2·9	9	L=(+0·3) 0; N=(−1·6) 1; C=(−0·9) 2; 0=(−0·8) 6	−1·4	FAS: normal	−0·7	Abnormal
9	−1·9	5	L=(−1·9) 2; N=(−0·9) 1; C=(−1·3) 1; 0=(−1·9) 5			0·0	Abnormal
10	Unable		Unable	Unable	Unable	Unable	Abnormal
11	+0·1	7	L=(−0·8) 0; N=(−1·2) 3; C=(−0·3) 5; 0=(−2·5) 5	−1·4	FAS: abnormal	−2·3	Abnormal
12	−2·5	7	L=(+0·7) 1; N=(+1·1) 1; C=(−0·3) 3; 0=(−1·0) 3	−0·7	A+F: normal	−0·7	Abnormal
13	−8·3	4	Unable	−2·4	Unable	−2·0	Abnormal
	−5·9	3	Unable	−3·4	Unable	−1·3	Abnormal

[1]Phonetic cues required.
[2]Rapid Automatized Naming Test: L = letters; N = numbers; C = colors; O = objects.
[3]F = foods; A = animals; FAS = words commencing with F, A and S.

Neuropsychological data for each child are summarized in Tables IIIa and IIIb.

Behavioral descriptions

Eleven of the 13 children exhibited attentional/behavioral abnormalities. Based on the total available medical documentation, including an interview with the mother, they all met DSM III-R criteria for attention deficit hyperactivity disorder (ADHD) (see Table II). Eight were investigated with a 25-item, 0- to 3-point rating scale for parents (K-FARS), specifically developed to be sensitive to a perseverative and 'overfocused' attentional style. In previous work (Kinsbourne 1991), we have found that most parents of ADHD children do not give their children high ratings on this scale. A distinctive 'overfocused' pattern of attention deficit could be distinguished from typical attention deficit by discriminant analysis with 100 per cent reliability, based on ratings for 10 items. The four most discriminating items were: (1) becomes preoccupied with impending, anticipated events; (2) may keep the same posture or facial expression for unusually long time-periods; (3) is quietly oppositional, stubborn; and (4) is shy.

Results

Clinical diagnosis of hypokalemic, hypochloremic metabolic alkalosis

For four of our 13 patients, serum electrolyte measurements documented hypochloremic, hypokalemic metabolic alkalosis. The other nine children, whose

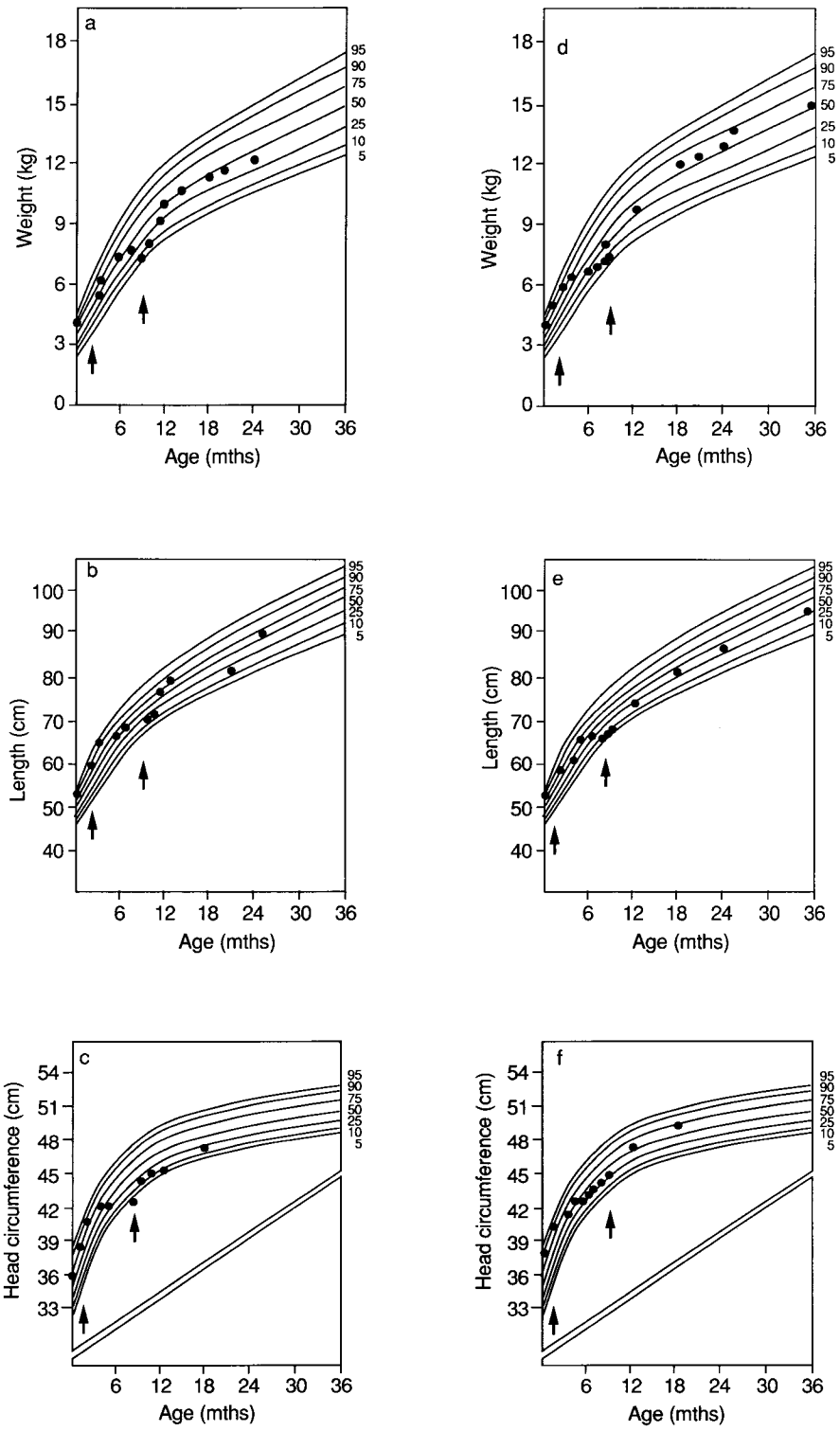

Fig. 1. Growth profiles of two infants: one with (a to c) and one without (d to f) chemically documented chloride deficiency. Arrows denote initiation and cessation of chloride-deficient formula.

serum electrolytes were not measured, were diagnosed on the basis of marked deceleration in weight-gain and in growth of head circumference after initiation of chloride-deficient NMS, and acceleration of both measures after withdrawal of the formula.

Two examples of this distinctive growth pattern are shown in Figure 1. Figures 1 *a*, *b* and *c* present the growth profiles of a child with biochemically documented chloride deficiency (case 2), Figures 1 *d*, *e* and *f* a child (case 1) without documented biochemical abnormalities. All 13 children showed deceleration of weight gain and of growth in head circumference. In 10 children there was also a deceleration of linear growth. Seven children's weight and six children's head circumference fell to the fifth centile or below; five children fell to fifth centile or below for both.

Two patients had growth measurements at extreme ends of the centile scales. Patient 11, whose weight dropped from the first to below the first centile, in fact fell 1·88 SD until formula replacement. Patient 4, whose head circumference was above the 99th centile at initiation of NMS, fell 0·73 SD, but less than 1 percentage point while taking the formula. All children resumed normal growth rates after the formula was discontinued, and in all cases head circumference was within the normal range at their most recent examination.

Relative decreases were most marked for weight. Head circumference deceleration was somewhat less severe and deceleration of linear growth least.

Neurological examination and neurodiagnostic studies

Examination of each of the 13 children disclosed no musculoskeletal abnormalities. Head circumference measurements at follow-up were all within normal limits. Three children had hypotonia of their extremities, two had diffuse hyperreflexia, one had chloreiform movements and one bilateral intention tremor.

EEG was abnormal for six of 12 children studied (Table II). Paroxysmal discharges were seen in five children (cases 1, 4, 9, 10 and 13): these were nonfocal in two (cases 4 and 9); for the others, the focus was localized to the occipital leads (case 1), the left temporal leads (case 10) and in both fronto-parietal regions (case 13).

Computerized tomographic electroencephalography mapping showed attenuation of visual and auditory evoked responses in the left posterior temporal region of the two children studied. CT and MRI studies were normal.

Residual cognitive deficit syndrome

At their initial examination, 11 of the 13 children scored within the average range of intelligence on the WPPSI, S-B or WISC-R; nevertheless all share a neurobehavioral syndrome consisting of a language disorder involving expressive phonological-syntactic abnormalities and difficulties in word finding or naming. Even the two globally markedly retarded children were disproportionately impaired in expressive language. Articulation patterns characterized by inconsistent phoneme distortions, substitutions and omissions were seen at initial examination of 10 of these 11 children. Case 10 was unable to vocalize.

Spontaneous utterances by all children were characterized by telegraphic and erratic grammatical constructions, and obvious difficulties with expression of ideas, concepts and words. Word associations in particular classes (*e.g.* animals and foods) were normal for all seven children tested; two of three performed poorly when alphabet letters were used as stimuli. Repetition and inappropriate interjection of both sounds and words from previous utterances occurred to varying extents. The word finding/naming deficit was particularly severe in two patients (cases 3 and 11); both had specific difficulties with color naming, despite normal color perception and color recognition.

The 11 children with average intelligence performed better on tests of language comprehension than language expression; performance on standardized tests of receptive vocabulary was normal. However, understanding of syntactic and grammatical complexity was below average for nine of the 11 at first examination. Discrimination of speech sounds in words was abnormal in two children (cases 4 and 5), although there was no pure-tone audiometric impairment.

Graphomotor and other fine upper-limb co-ordination skills also showed consistent abnormalities. 10 of 11 children performed significantly below average when copying geometrical designs on the VMI. Sequencing of hand or finger movements was particularly deficient in all children. In addition, all had impaired flexion-extension movements of the lower extremities.

In behavior and social functioning there were also many common factors. All 11 non-retarded children were cognizant of their difficulties, and both clinical observations and parent reports indicated low self-esteem, as demonstrated by self-deprecating expressions and reluctance to speak during conversations. In more structured examination situations, all the children demonstrated communicative intent by using gestures and/or hurried speech to sustain interactions. Children tended to withdraw at times from social situations and to isolate themselves at home. Parents also reported high levels of activity and repetitive behaviors, such as hand-patting, scribbling with a pencil, manipulation of the mouth and rocking or head-banging. Each child was easily distracted by internal or external stimuli. On the rating scale, six children (cases 1, 2, 4, 6, 9 and 13) met criteria for overfocus, and one child (case 8) scored marginally.

Discussion

The evidence that chronic chloride-deficiency was solely responsible for the failure to thrive of infants exposed to chloride-deficient NMS has been reviewed by Grossman *et al.* (1980) and Roy and Arant (1981). The characteristic serum electrolyte abnormalities of hypochloremic, hypokalemic metabolic alkalosis were documented in four of our 13 patients. For the remainder, the diagnosis were based on marked deceleration in weight-gain and head circumference growth after starting to take NMS, and their acceleration after withdrawal of the chloride-deficient formula. Alternative diagnoses, such as Bartter syndrome, could be readily excluded, not only by lack of supporting evidence but also by the children's recovery when the deficient formula was discontinued or appropriately supplemented. The findings in this sample were more striking than those of Willoughby *et al.* (1990), but those authors included any child exposed to NMS and did not perform extensive neuropsychological testing.

Failure of body growth secondary to dietary chloride-deficiency is associated with a remarkable degree of vulnerability of brain growth, as shown by an arrest or slowing in the growth of head circumference. This susceptibility of brain growth to chloride deficiency contrasts with its relative resistance to undernutrition, whether it be the result of deficient caloric or protein intake or malabsorption. Indeed, head circumference is considered to be resistant to both organic and non-organic causes of failure to thrive, and has therefore been used as a predictor of optimal weight and length (Collins and Mezey 1984).

The specific developmental dysphasia found in our patients primarily involves expressive skills, and resembles the 'Group 1—expressive group' described by Wolfus *et al.* (1980), characterized by deficits in phonological and syntactic production, with relatively good receptive abilities. Our patients also have aspects of Rapin's (1982) 'mixed phonological-syntactic syndrome', and 'phonologic programming deficits syndrome', both of which include striking discrepancies between expression and comprehension; often adequate for simple, routine situations, but impaired for complex situations. Longitudinal data collected on four of our children so far have shown that these disabilities persist.

Deficient attention is not uncommon in conjunction with a developmental language disorder (Ludlow *et al.* 1983). In seven of our children, the defect in attention took the unusual form of attentional overfocus (Kinsbourne 1991). These children demonstrated rigid and perseverative attentional behavior, and avoided overstimulation and multiple demands. The usual pattern of unpredictable restlessness was not seen. In contrast, our patients exhibited repetitive movements of arms and fingers when cognitively overloaded or exposed to

novel or unpredictable situations. The prominence of this uncommon attention deficit variant in the present group supports the view that this is not a random conjunction of symptoms. While undernutrition of experimental animals during early life may induce persistent abnormalities in brain structure and function, extrapolation to the human situation is still a matter of considerable controversy (Barrett 1987). However, a specific developmental dysphasia, as demonstrated in our patients, has not previously been associated with undernutrition, nor with various conditions such as cystic fibrosis or Bartter syndrome that induce chloride deficiency (Cravioto and DeLicardie 1975).

The morphological and biochemical changes in the brain that result from chloride deficiency during early postnatal development are completely unknown. Neuro-imaging studies at follow-up on two of our patients were completely normal. In particular, there was no evidence of impaired myelination. However, it is not surprising that a transient malnutritional deficit of sufficient magnitude to interfere with brain growth could have subsequent serious effects on cognitive development. Indeed, the specific symptomatology reported here may not be the only possible adverse long-term consequence of early dietary chloride deficiency.

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SUMMARY
Eleven of 13 children, who demonstrated a failure-to-thrive pattern in infancy attributable to chloride-deficient Neo-Mull-Soy formula, had distinctive cognitive impairments four to nine years later. These included: a language disorder primarily involving articulation, word finding and naming; visual-motor and fine motor difficulties; and attention deficit disorder, often featuring repetitive behaviours, withdrawal and perseveration ('overfocus'). In contrast, global intellectual abilities were within the normal range in all 11 children. This residual neurobehavioral syndrome is too rare in the developmentally disabled population to reflect a chance association. It has not been associated either with protein-calorie malnutrition or chloride-deficiency diseases.

RÉSUMÉ
Syndrome neuro-comportemental à la suite d'un défaut de développement lié á une déficience en chlorures
Onze de 13 enfants qui présentèrent un groupement de défaut de développement durant la première enfance attribuable à une formule Néo-Mull-Soy de déficience en chlorures, ont présenté des défauts cognitifs particuliers quatre à neuf ans plus tard. Ces défauts incluaient un trouble de langage comprenant principalement un défaut d'articulation, un défaut d'évocation des mots et de la dénomination; des difficultés visio-motrices et du geste fin, un déficit d'attention, des comportements répétitifs fréquents avec retrait et persévération en 'sur-concentration'. Par contraste, les capacités intellectuelles globales de ces onze enfants étaient à un niveau normal. Ce syndrome neuro-comportemental résiduel est trop rare dans la population des troubles de développement pour pouvoir être expliqué par un facteur d'association aléatoire. Il n'a pas été trouvé associé à une malnutrition par défaut de protéines ou de calories ou par des affections entraînant des déficits de chlorures.

ZUSAMMENFASSUNG
Ein verhaltensneurologisches Syndrom nach einer Gedeihstörung durch eine chloridarme Ernährung
11 von 13 Kindern, die im Kindesalter eine Gedeihstörung aufgrund einer chloridarmen Neo-Mull-Soy Diät aufwiesen, hatten vier bis neun Jahre später erhebliche kognitive Störungen. Dazu gehörten: eine Sprachstörung, die besonders die Artikulation, die Wort- und Namenfindung betraf visuell motorische und feinmotorische Probleme; und Aufmerksamkeitsstörungen, gekennzeichnet durch Wiederholungen, Abschalten und Perseverationen ('Overfocus'). Dagegen waren bei allen elf Kindern die globalen intellektuellen Fähigkeiten im Normbereich. Dieses verhaltensneurologische Residualsyndrom ist bei den Patienten mit Entwicklungsstörungen zu selten, um eine Assoziation zu einer Mangelernährung herzustellen. Es ist weder mit einer Proteinmangelernährung noch mit Chloridmangel-Erkrankung assoziiert worden.

RESUMEN

Síndrome neuroconductal después del fallo en el crecimiento usando una lactancias artificial con deficiencia en cloruros

Once de 13 niños que habían mostrado un fallo en el crecimiento durante la lactancia, atribuible a un biberon de Neo-Mull-Soy con déficid de cloruros mostraban alteraciones cognitivas bien definidas de cuatro a nueve años después. Estos consistían en: Una alteracion en el lenguaje que afectaba primariamente la articulacion, el hallazgo de palabras y la nominacion; dificultades viso-motoras y de la motilidad fina; y un déficid en la atención, dando lugar a menudo a comportamientos repetitivos, retirada y perseveración (sobrefocalizacion). En contraste, las habilidades intelectuales globales estaban dentro de los límites normales en estos once niños. Este síndrome neuroconductal residual es demasiado raro en la población con alteración del desarrollo, para reflejar una asociación concreta. No se ha asociado ni con una malnutrición proteino-calórica ni con una enfermedad por déficid de cloruros.

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