Predictive value of preschool surveillance in detecting learning difficulties

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Abstract

Objectives—The Hall report specified the early detection of mild to moderate learning difficulties as one aim of child health surveillance (CHS). This study examines the efficacy of preschool CHS in the early recognition of children with these disorders.

Design—A retrospective case-control study.

Subjects—All children (n=408) with mild to moderate learning difficulties born between 1 July 1983 and 30 June 1984 and resident in North and West Belfast.

Controls—2406 birth records and 150 full child health records controlled for age and geographical area.

Results—The prevalence of mild to moderate learning difficulties in North and West Belfast was 16%. Only 6% of children with learning difficulties were identified by the CHS in the preschool period, although the detection rate for children eventually requiring placement in schools for moderate learning difficulties was better. Coverage of the CHS ranged from 90% at the 2 year examination to 98% at the 4 year examination. Perinatal variables associated with learning difficulties after multiple logistic regression analysis were lower social class (odds ratio (OR) 3.9), prematurity <35 weeks (OR 3.0), male sex (OR 1.6), and birth to an unmarried mother (OR 0.6). Independent preschool variables identified by the CHS were speech delay (OR 3.3), poor parenting skills (OR 4.0), behaviour problems (OR 2.8), enuresis (OR 2.4), poor visual acuity (OR 1.8), and otitis media with effusion (OR 1.4). A statistical model for the early detection of learning difficulties using these risk factors is unable to predict accurately the children who will develop mild to moderate learning difficulties.

Conclusions—The CHS as it existed from 1983 to 1989 in North and West Belfast was poorly sensitive to the detection of mild to moderate learning difficulties despite excellent coverage. An accurate predictive model for learning difficulties could not be developed from the risk factors documented by the CHS.

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The Hall report (1989,1991) set out a series of challenges for everyone involved in child health surveillance(CHS).[1] The aims and objectives of the existing CHS were clarified and a tentative programme for change set out. Hall emphasised the need for careful research and audit of present practice in order to facilitate service development. This paper aims to examine one outcome measure of CHS, the early detection of mild to moderate learning difficulties, and discuss the implications of its findings for current practice.

Historically CHS has always had a strong developmental emphasis. Screening has been aimed at detecting subtle developmental disorders often associated with problems such as mild learning difficulties, speech and language delay, and clumsiness.[2] The detection of mild to moderate learning difficulties is therefore a valid outcome measure of child health developmental surveillance.

Learning difficulties are a common group of disorders with significant long term morbidity in terms of educational achievement, social interaction, and psychiatric disorders.[3][4] Environment can have either positive or negative effects on learning difficulties.[5][6] Early detection of learning difficulties and interventions to ameliorate abnormal patterns of learning and secondary behavioural and emotional difficulties have been shown to be beneficial.[6-8] The efficacy of preschool screening programmes in the early detection of learning difficulties is unclear and there is little information on current CHS practice.

Methods

North and West Belfast is a deprived inner city area with a population of 180 000. There are 60 mainstream primary schools, two for moderate learning difficulties, and two for severe learning difficulties serving the area. The CHS at the time of the study involved nine mandatory examinations (table 1) with varying numbers of follow up visits. Mild to moderate learning difficulties were defined as any child in mainstream education requiring remedial assistance for ability two or more years behind in one or more subjects or any child attending a school for moderate learning difficulties.

The population studied was drawn from all children born between 1 July 1983 and 30 June 1984 with maternal addresses in North and West Belfast. Children were 7 to 8 years old at the time of the study ensuring a minimum of

Table 1   Timing and content of mandatory examination points for the CHS 1983 - 90

	Time of visit								
	First visit	*6 Weeks*	*6 Months*	*12 Months*	*18 Months*	*2 Years*	*3 Years*	*4 Years preschool*	*5 Years RMI*
Health worker involved	HV	HV+ GP/CMO	HV	HV	HV	HV	HV	HV	HV+ CMO
Test			MST	MST	MST				

CMO = community medical officer; GP = general practitioner; HV = health visitor; RMI = routine medical inspection; MST = Mary Sheridan test.

two years full time primary school education to facilitate detection of significant learning difficulties by their teachers. Children were excluded if the school they attended refused to participate in the study, if they attended a school for severe learning difficulties, or if they were known to have a physical problem likely to contribute to or mimic learning difficulties such as moderate to severe sensorineural deafness, severe visual handicap, etc.

The study group comprised those children attending participating schools and felt by their teachers to meet the study criteria for mild to moderate learning difficulties. The controls were the children attending the same schools, within the same age range, and felt by their teachers not to have significant learning difficulties.

Data from CHS were separated into perinatal data and preschool data. Perinatal data collected are detailed in table 2. These data were available as computerised records for children in both the study group and controls. Preschool data were obtained by personal review of the written child health record and recorded on a specially designed database. All children with learning difficulties and a 10% random sample (225 children) of the control group had their child health record examined.

The percentage of children identified by CHS as having either developmental delay or learning difficulties within the preschool period formed the principal outcome measure. The diagnosis of developmental delay was accepted where it was either documented in the child health record or where there was evidence of referral to educational psychology or developmental paediatric services for further assessment. The identification and documentation by CHS of known risk factors in either perinatal or preschool surveillance of later learning difficulties were examined as immediate outcomes.

Univariant and multiple logistic regression analysis was used to identify risk factors associated with later learning difficulties. A score based on these risk factors was then calculated for each child. This represented a predictive score for the risk of later mild to moderate learning difficulties. The differences in these scores for the learning difficulties and control

groups were examined to establish the sensitivity, specificity, and predictive value of any screening process based on the existing system of CHS. This process was done for the perinatal data and preschool data independently. The databases were then merged to include all children for whom full perinatal and preschool data was available.

Results
Fifty six (92%) of the 62 local primary schools agreed to participate in the study, including both schools for children with moderate learning difficulties. There were 2561 children within the correct age range attending these schools. Of these, 21 children were attending primary schools for moderate learning difficulties and 387 were receiving remedial help at mainstream schools giving a total of 408 (16%) children with learning difficulties. Of these 408 children complete perinatal data was available for 380 (92%) and complete preschool data for 355 (87%).

The computerised perinatal records showed 3088 children were born to mothers from North and West Belfast during the study period. Of these, 248 children attended non-participating schools, 26 had either severe learning difficulties or other excluding disorders, and 408 had learning difficulties leaving a dataset of some 2406 children in the control group. The extra 253 children were untraceable. Of the 225 controls that also had their child health record reviewed 183 (81%) had full data available. All the children with complete preschool data also had complete perinatal data and formed the cohort for the combined analysis of predictive scores.

Eight per cent of the study group were identified as being at risk of learning difficulties before starting school. Only 75% of these were directly or indirectly identified through CHS. However 62% of the children with learning difficulties that warranted placement at a primary school for moderate learning difficulties were identified as at risk of learning difficulties in the preschool period, very significantly more than the children in mainstream primary schools (relative risk=10.3).

The coverage of the mandatory visits ranged from 98% at first visit to 86% at 2 years with a

Table 2   Perinatal data collected on each child

Health visitor	No of previous pregnancies	Delivery mode
Sex	No of previous stillbirths	Mother's age
Date of birth	No of previous livebirths	Father's age
Address	Gestation	Social class
No of antenatal visits	Birth weight	Marital status
No of weeks worked	Multiplicity	Maternal abnormalities
		Congenital abnormalities

Table 3   Percentage coverage of mandatory examination points; values are per cent seen

	Time of visit							
	First visit	6 Weeks	6 Months	12 Months	18 Months	2 Years	3 Years	4 Years
Children with learning difficulties	98	95	96	92	95	88	90	96
Controls	99	99	97	92	93	83	88	96

mean of 94%. There was no significant difference in coverage between the control and learning difficulties groups (table 3). The mean (SD) number of visits for each child was 17.7 (8.7). Of the 48 different tests employed by the Mary Sheridan screening test only nine were

Table 4   Outcome of Mary Sheridan developmental tests in children with learning difficulties compared with controls

Test	% Failed in children with learning difficulties (n=355)	% Failed in controls (n=183)	p Value
At 6 months			
Holds head erect	0.6	0	0.43
Gives arms when lifted	3.3	3.0	0.77
Foot regard	1.5	0.5	0.32
Rolls	3.3	2.9	0.77
Stops crying when talked to	0	0	n/a
Turns head to voices	0.6	0	0.4
Brings toys to mouth	1.2	0	0.18
Drinks from cup with assistance	3.3	6.0	0.2
Laughs	0.5	0	0.43
Babbles	0.5	0	0.43
Turns head to sound	5.0	4.0	0.56
Four different sounds	1.8	0	0.07
Picks up toy	0.14	0	0.11
Pulls paper from face	1.5	0.5	0.32
Holds two objects	1.5	0	0.12
Looks for objects	1.2	0	0.18
At 12 months			
Stands aided	1.9	0.5	0.23
Crawls	1.6	0.5	0.32
Walks aided	3.7	5.0	0.43
Stands alone	8.4	7.6	0.7
Waves bye bye	1.5	0	0.12
Plays pat a cake	4.6	3.8	0.6
Helps dress	1.7	2.5	0.42
Uses spoon	2.4	3.1	0.89
Two words with meaning	5.6	4.1	46
Follows simple commands	0.5	0	0.42
Knows name	0.3	0	0.65
Three words with meaning	8.7	12.6	0.2
Pincer grasp	0.6	0	0.17
Scribbles	7.0	4.7	0.32
Points	2.8	0.5	0.08
Hand preference	6.2	5.8	0.9
At 18 months			
Climbs small step	1.0	0	0.28
Walks pulling object	1.2	0	0.18
Walks backwards	3.2	0.5	0.06
Climbs stairs	2.2	0	*0.05
Uses cup–no mess	0.6	0	0.42
Removes own shoes	0.6	2.4	0.12
Asks to use toilet	60.0	47.0	*0.01
Bowel control complete	70.0	79.0	*0.02
Babbles freely	2.2	0	*0.05
Watches pictures	3.0	0	*0.01
Ten words with meaning	36.0	7.6	* 0.0001
Repeats words	11.0	3.5	*0.004
Scribbles constructively	1.5	0	0.12
Plays constructively	5.5	0	*0.002
Builds tower of three bricks	5.0	1.2	*0.04
Throws ball	1.2	0	0.18

significantly discriminatory of later learning difficulties and all of these were at the 18 month test period (table 4).

Univariant analysis showed a number of perinatal and preschool variables were associated with a increased relative risk of later learning difficulties (tables 5 and 6). However after multiple logistic regression analysis only lower social class (odds ratio (OR 3.9), prematurity <35 weeks (OR 3.0), male sex (OR 1.6), and birth to an unmarried mother (OR 0.6) in the perinatal dataset and speech delay (OR 3.3), poor parenting skills (OR 4.0), behaviour problems (OR 2.8), enuresis (OR 2.4), poor visual acuity (OR 1.8), and otitis media with effusion (OR 1.4) in the preschool period were associated with learning difficulties (table 7). In the preschool period 23% of children who went on to develop learning difficulties had no significant risk factors documented in their child health record.

Figure 1 shows the spread of predictive values using a combined perinatal and preschool variable model. In order to identify 85% of the children at risk using this model one would have to screen 62% of the total population.

Discussion
Recent changes within the National Health Service have placed increasing emphasis on developing outcome measures that can be used to evaluate clinical practice. In particular the implementation of screening programmes such as CHS with large resource implications should be based on sound scientific research.

Learning difficulties are a common condition [9] [10] with significant morbidity [3] [4] and proved efficacious intervention [7] [8] and thus fulfil three basic criteria for screening. What remains to be established is the validity of the tests currently used in the detection of children with learning difficulties in the preschool period. The good case ascertainment rates, well defined geographically limited population,
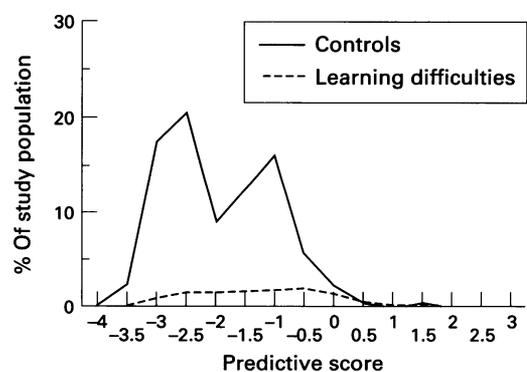

Figure 1   Spread of predictive scores between children with learning difficulties and controls.

Table 5 Perinatal risk factors associated with later learning difficulties

Risk factor	% Children with learning difficulties (n=380)	% Controls (n=2406)	OR	95% Confidence interval
Lower social class (social class V or less)	254 (67)	950 (39)	3.1	2.5 to 3.9
Prematurity (35 weeks)	25 (7)	51 (2)	3.2	2.0 to 5.1
Multiple birth	12 (3)	40 (1.6)	1.9	1.0 to 3.7
Low birth weight (2500 g)	39 (10)	148 (6)	1.7	1.2 to 2.5
Male sex	233 (61)	1194 (50)	1.6	1.3 to 2.0
Unmarried mother	90 (24)	449 (19)	1.3	1.0 to 1.7
Assisted delivery	87 (23)	541 (22)	1.0	0.8 to 1.3

Table 6 Prevalence of documented problems in children with learning difficulties compared with controls

Problem documented	Total % with problem in children with learning difficulties (n=355)	Total % with problem in controls (n=183)	p Value	OR (95% confidence interval)
Developmental				
Speech delay	46	18	0.0001	3.8 (2.4 to 6.0)
Behavioural problems	9	3	0.01	3.6 (1.3 to 10.8)
Global delay	5	0	0.01	Undefined
Poor gait	4	3	0.6	
Poor feeding	5	3	0.3	
Poor concentration	6	1	0.01	5.1 (1.2 to 45.4)
Gross motor delay	3	2	0.4	
Hyperactivity				
Clumsy	3	1	0.09	3.2 (0.7 to 29.4)
Hypotonia	1	1	0.7	
Fine motor delay	1	0	0.1	Undefined
Hearing				
OME +/– vents	25	18	0.08	1.5 (0.9 to 2.3)
Failed hearing test	4	3	0.8	
Adenoidal hypertrophy	1	1	0.3	
Medical				
Enuresis	8	3	0.03	2.6 (1.0 to 7.8)
Asthma	5	7	0.4	
Cardiac murmur	5	2	0.08	2.5 (0.8 to 10.4)
Eczema	2	3	0.6	
Febrile seizures	3	1	0.2	
Non-febrile seizures	1	1	0.5	
Constipation	1	0	0.4	
Oesophageal reflex	1	1	0.5	
Inguinal hernia	2	0	0.03	Undefined
Undescended testes	1	1	0.9	
Environmental				
Poor housing	14	5	0.01	2.7 (1.3 to 6.0)
Poor parenting	9	2	0.001	6.2 (1.9 to 31.6)
Maternal depression	3	2	0.2	
Poor home environs	4	1	0.08	3.4 (0.8 to 31.6)
Abuse	3	1	0.1	4.7 (0.6 to 208)
Alcohol abuse (parent)	2	0	0.08	Undefined
Financial problems	2	1	0.2	
Vision				
Poor visual acuity	16	9	0.01	2.0 (1.1 to 3.8)
Squint	8	6	0.6	
Growth				
Small stature	8	5	0.2	
Failure to thrive	3	2	0.2	
Microcephaly	1	1	0.9	
Obesity	1	1	0.5	

OME = otitis media with effusion.

and the high participation of local schools minimised bias by educational provision, social class, environmental pressures, or different ethnic mixes.

The 253 children on the perinatal database that were not accountable for had presumably either left the area or died. If we accept 16% of these as having learning difficulties, this would represent a 1% contamination of the 2406 controls with false negatives that would be statistically acceptable and unlikely to effect the results.

In this study CHS examinations failed to detect the majority of children with mild learning difficulties and missed 38% of children with moderate learning difficulties. The improved detection rate for the children at schools for moderate learning difficulties may be related to the more severe nature of their

learning difficulties. However early detection itself may make appropriate placement more likely, whereas late detection may delay placement in a suitable environment. Retrospective analysis of the child health record also failed to identify a model that would predict children at risk of later learning difficulties. These findings have implications for the future development of CHS.

Why children with learning difficulties were not detected was also examined. Possible reasons include inadequate or inappropriate timing of examinations, poor application of the screening tests, or the use of inappropriate screening tests. The natural progression of the condition may also be such that early detection is not possible.

The failure of CHS is unlikely to be due to timing of examinations as each child had nine

mandatory visits and an average of nine follow up visits in the preschool period, considerably more than recommended today.[1]

There is a wide choice of developmental screening tests available that vary in clinical accuracy.[11] The validity of a test in predicting school performance can vary and teacher assessment can be just as accurate.[12] [13] The 'pass/fail' style of developmental assessment used in this study is more structured than those presently recommended,[1] which are based more on clinical judgment. However as results based on clinical judgment been shown to correlate well with pass/fail testing [14] [15] it is unlikely that this difference is responsible for the failure of CHS.

It is unlikely that the tests were poorly applied. All health visitors were fully trained in the developmental techniques employed. The excellent coverage indicates a dedicated and motivated workforce, despite the recognised difficulties of working in an inner city area.[16] In addition the high prevalence of documented speech delay suggests that at least parts of the tests were applied correctly.[11]

The natural history of learning difficulties overlaps with normal developmental making early detection difficult. Previous studies have established the predictive value of certain parental, perinatal, and preschool variables in detecting learning difficulties.[17] [18] Many of these used test conditions or included variables that would be difficult to apply to a nationwide screening programme because of implications for training or resources. Our study differed in that it examined the screening programme currently in place for all children. We found that although certain variables were significantly more common in children with learning difficulties, they could not be used to construct an accurate predictive model for later learning difficulties. The majority of risk factors documented (tables 4–7) are well recognised associations of learning difficulties.

We contend that the failure of CHS was due to a combination of poor test sensitivity and the wide overlap of learning difficulties with variants of normal development.

Table 7   Risk factors associated with learning difficulties after multiple logistic regression analysis

Risk factor	OR	95% Confidence interval
Perinatal		
Lower social class (IV - VII)	3.9	3.0 to 4.9
Prematurity	3.0	1.4 to 5.1
Male sex	1.6	1.3 to 2.1
Unmarried mother	0.6	0.4 to 0.8
Preschool		
Speech delay	3.3	2.1 to 5.2
Poor parenting skills	4.0	1.1 to 14.0
Behavioural problems	2.8	1.0 to 7.6
Enuresis	2.4	0.9 to 4.1
Poor visual acuity	1.8	1.0 to 3.3
Otitis media with effusion	1.4	0.9 to 2.3

Conclusions

The CHS did not meet its stated aim of early detection of children with learning difficulties. Our study would suggest that shortcomings in coverage, timing of the visits, or application of the screening tests used are unlikely to be major contributors to this failure. It is more likely that the tests employed were not sensitive enough to differentiate between minor developmental problems in children with learning difficulties and variants of 'normal' development. The value of early detection and intervention for children with learning difficulties is established. More studies are required to determine if other screening tests can meet the requirements of efficacy and time restraints that would allow earlier detection of these at risk children. Exploration of other options for surveillance such as mandatory nursery school placement combined with increased parental and professional awareness may provide a more accurate method of recognising children with significant developmental delay and targeting already stretched resources.

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