Predicting Needs for Special Education Resources for Mental Retardation from Birth Defects Records

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Synopsis

Planning of service delivery systems for children with special health care needs would be enhanced by knowledge of numbers of cases anticipated in defined geographic areas.

A method is described for predicting numbers of children who will likely have mental retardation sufficient to require special education services, based on the birth prevalence of birth defects and clinicians' estimates of the likelihood of mental retardation associated with each specific birth defect.

This method is applied to the 1980-82 birth cohort of a 28-county area of south and central Arkansas, and it is compared with special education enrollment data for children ages 6 to 8 in academic year 1988-89. According to this estimate, children with birth defects may account for 32 to 56 percent of the cases of mental retardation among 6- to 8-year-olds reported by the public schools.

A MAJOR OBJECTIVE OF BIRTH DEFECTS surveillance is to provide estimates of the number of affected children in order to plan services, including special education, that they will need (*1-3*). A large but unspecified number of children with functional handicaps also have birth defects. The purposes of this report are to estimate the contribution of congenital anomalies and multiple congenital anomaly syndromes to the total population of mentally retarded (MR) children in a well-defined geographic area and to compare that estimate to the reported prevalence of MR in the current service delivery system. In addition, these data have implications for newly mandated services such as early intervention.

Methods

This analysis of population-based surveillance data includes (*a*) independent estimation of the probability of association of MR with each birth defect by a dysmorphologist and a developmental pediatrician, using standard texts, literature reports, and clinical experience; (*b*) application of these probabilities to cases of birth defects within the study cohort to estimate the number of children having MR; and (*c*) comparison of the estimate of mental retardation prevalence in the study cohort (born 1980–82) with that reported by the cohort's public school system for the school year 1988–89.

Case ascertainment. The Arkansas Reproductive Health Monitoring System routinely monitors cases of adverse pregnancy outcome in the State. This system is administered by Arkansas Children's Hospital and professionally directed by faculty of the University of Arkansas for Medical Sciences. This study encompasses outcomes of liveborn infants of 28 counties of central and south Arkansas for the 3-year period 1980–82. Cases of birth defects were actively sought in the records of all hospitals and Head Start programs serving the area, including all referral hospitals. The data are population-based, covering 52,490 live births. Problem cases were ascertained through inpatient records and through logbooks kept in nurseries, surgical suites, delivery rooms, and selected pediatric clinics. Medical record review was performed

for all infants' cases, and maternal chart review was conducted when an infant with a birth defect was identified in the hospital of birth.

Data abstracted included maternal address and infant's race, sex, hospital of birth, date of birth, hospital source of abstract, specific suboptimal pregnancy outcomes, parental occupations, maternal history (complications, illnesses, drugs, smoking, and alcohol use), and family history (birth defects, consanguinity, epilepsy, deafness, mental retardation, other). Problems were coded according to the British Pediatric Association Classification of Diseases, a modification of the International Classification of Disease, Clinical Modification, Version 9 (ICD-9-CM), as modified by the Centers for Disease Control (CDC), Division of Birth Defects and Developmental Disabilities, to exclude normal variants (*4*). This methodology has been reported previously (*5*).

Probability estimates. A compilation of the 1,027 ICD-9-CM 6-digit disease codes (including qualifiers such as bilateral, left, and probable) for birth defects was reviewed independently by a developmental pediatrician (C.F.) and a dysmorphologist (C.C.). Based on standard references (*6–8*) and personal experience, an estimate was made of the frequency of mental retardation within the group of persons assigned a designated code. For most conditions, such as Down syndrome and spina bifida, for example, standard references provided reliable data regarding the prevalence of MR associated with the birth defect or syndrome. In other conditions, such as cleft lip and omphalocele, it was necessary to derive estimates which considered that these defects may be seen in isolation or as one feature of a broader pattern of altered development. In other conditions, such as esophageal fistula and uterine anomalies, no accurate objective data were available, so that the estimate must be considered, of necessity, to be derived from the experience of clinicians, and therefore it is subject to some arbitrariness. The range of 5 to 15 percent was chosen for these conditions without reliable data and for which the probability was thought to be low, but present, in order to reflect the uncertainty of probability estimates.

Prevalence estimates from birth defects data. Prevalence estimates for mental retardation were derived by applying our probability estimates to the population-based cohort of infants diagnosed with birth defects and alive at the time of medical record abstraction. Because it is not known whether multiple problems contribute additively to MR probability, estimates for infants with more than one birth defect were derived in two ways: using the defect with the highest MR probability as the maximum or using the sum of the probabilities as the maximum (not to exceed 1.0). Each infant was therefore assigned a probability of mental retardation of 0.0–1.0. These probabilities were summed across all cases to obtain an estimate of the prevalence of mental retardation among all children with birth defects. The probability ranges and the range of discordant ratings are the bases for estimates of minimum and maximum number of cases anticipated to have mental retardation within this cohort (that is, the lowest rating or rating of 5 percent for 'low' probability forms the minimum).

From the cohort of 52,490 live births, 1,659 infants were identified as having one or more birth defects. Deletion from the data set of those infants who were stillborn, those who were no longer alive at time of hospital abstract, and those who had a birth defect highly associated with early death, yielded a total of 1,506 infants likely to require care and intervention services.

Prevalence estimates from special education data. The number of children designated as mentally retarded (I.Q. less than 70) by public schools serving the 28-county study area was obtained from the Arkansas Department of Education, Division of Special Education, for the school year 1988–89. Children are designated as mentally retarded based on test results from one or more of a list of standard assessment tools, administered by school psychologists or other trained professionals. Data showing the distribution of these children by I.Q. are unavailable. These children (ages 6–8 years) correspond to the study cohort with birth years in the period 1980–82. Prevalence ratios of mental retardation from public schools in the study area were calculated and were compared with national data (*9*) as a measure of the representativeness of the study population.

Results

Probabilities assigned to each of the birth defects codes for disorders with concordance in probability estimate are listed in table 1. The two raters agreed on probability assignments for 92.4 percent of the 1,027 codes. Only 44 (2.9 percent) of the cohort of infants with birth defects had a diagnosis within the group of disorders with discordant probability

Table 1. Probability estimates of mental retardation

ICD–9–CM codes[1]	Disorders included
Probability = 0.8–1.0	
740;742.0–.1	Anencephaly; encephalocele; microcephalus
742.20;.28;.90	Other specified brain reduction; unspecified brain or spinal cord or nervous system
742.24–.27	Agyria; microgyria; holoprosencephaly; arrhinencephaly
742.31–.32;.81	Dandy-Walker Syndrome; hydranencephaly; familial dysautonomia
742.41–.50	Porencephaly; multiple cerebral cysts; other specified brain
743.00–.104	Anophthalmos; microphthalmos, bilateral
743.52; 748.185	Optic disc anomaly; tubular nose
756.447;.54	Thanatophoric dwarfism; osteopetrosis
757.10	Harlequin fetus
758.0–.528;758.55–.59	Chromosomal anomalies
758.91–.99	Chromosomal addition, deletion, duplication, abnormality not otherwise specified
759.82;.84;.87	Congenital malformation with short stature or involving limbs or with metabolic disturbances
Probability = 0.5–0.75	
742.21–.23	Corpus callosum, hypothalamus, cerebellar anomaly
742.30	Aqueduct of Sylvius anomaly; unspecified hydrocephaly
742.51;.88;.99	Atelomyelia; other specified or unspecified nervous system
743.10;.38	Microphthalmos; other specified lens anomaly
743.34;.43	Lens coloboma; iris coloboma
743.48–.50	Other anterior eye
745.60–.61	Single common atrium; ostium primum defects
745.62–.69	Common atrioventricular canal; endocardial or other cushion defect
754.20;756.056–.057	Congenital postural scoliosis; acrocephalosyndactyly, type III or other
756.446;757.110	Metatrophic dwarfism; collodion baby
757.35–.36	Incontinentia pigmenti; xeroderma pigmentosum
758.83; 759.80	Mosaic including XXXXY; congenital malformation affecting face
Probability = 0.25–0.49	
741	Spina bifida
742.40;.91	Macrocephaly; unspecified spinal cord
743.102;.32	Microphthalmos, unilateral; cataract
743.39–.42;.44	Unspecified anomaly of lens or cornea; absence of iris; other iris
743.53;.63;.636	Choroid anomaly; other eyelid anomaly
743.81;744.00–.01	Epibulbar dermoid cyst; ear or auricle or auditory canal absence
Probability 0.25–0.49 continued	
744.214;.80;.88	Microtia, bilateral; macrostomia; other specified face or neck
748.0;752.00–.01	Choanal atresia; ovarian absence or agenesis or streak
752.70;.865	Hermaphroditism; hypoplastic penis
753.0;.32	Kidney absence or agenesis or dysgenesis or hypoplasia or fused or lobulation
754.22;.825	Congenital postural spine curvature; shield chest
756.04–.05	Craniofacial dysostosis; acrocephalosyndactyly not otherwise specified
756.065;.085	Hemifacial macrosomia; hypertelorism
756.38;.40	Other sternum anomaly; asphyxiating thoracic dystrophy
Probability = 0.25–0.49	
756.43–.445	Achondroplasia or diastrophic dwarf; other specified chondrodystrophia
756.45–.46	Metaphyseal dysostosis; spondyloepiphyseal dysplasia
756.610–.617	Congenital diaphragmatic hernias; hemidiaphragm
756.70	Exomphalos-omphalocele
758.69–.81	Turner syndrome (karyotype unspecified); Klinefelter; Mosaic XO/XY, XO/XX
758.88–.90	Sex chromosome anomaly (other specified or unspecified); Mosaic not otherwise specified
Probability = 0.05–0.15	
743.21–.31	Enlarged eye or cornea; lens spherical or absent
743.60–.62	Blepharoptosis; estropion; entropion
743.632–.635	Blepharophimosis; other eyelid
743.67;.90	Anomaly of orbit or unspecified eye
744.03;.22–.30	Inner ear; ears misshapen or misplaced; eustachian tube absent
744.41–.48	Preauricular sinus; other branchial cleft anomaly
745.0–.59;.7–.9	Bulbus cordis anomaly; cor biloculare; other septal closure
746.0–.99	Other congenital heart anomaly
747.0–.39	Circulatory system congenital anomaly
749.0–.07;.09	Cleft palate
749.1–.29	Cleft lip
750.10–.11;.13	Aglossia; hypoglossia; tongue dislocated or displaced
750.30–.33	Esophageal fistula
751.11–.41	Anomaly of lower alimentary system
751.53–.59	Other intestinal anomaly
752.20–.31;752.38–.39	Uterine anomalies
752.41–.42;752.60–.62	Vaginal anomaly; hypo or epispadias
753.01;.16–.20	Unilateral kidney absence or hypo-

associated with specific birth defects

ICD–9–CM codes[1]	Disorders included
Probability 0.05–0.15 continued	
	plasia or dysplasia; hydronephrosis; cystic kidney
753.29–.31;.33	Ectopic or accessory or multiple kidney; other obstructive renal anomaly
753.41–.48;.60	Accessory or ectopic ureter; other ureter
753.62–.69	Urethral anomalies
754.21;.5–.78	Congenital postural lordosis; foot deformities
754.85–755.60	Deformity of hand or digits or limb or shoulder
755.665–.667	Hip dysplasia
755.685–756.03	Other limb anomaly; craniosynostosis
756.07;.08–.09	Localized skull defects; unspecified skull or face bone anomaly
756.11–.36	Anomaly of vertebrae or sacrum or spine or ribs or sternum
756.39;.48–.506	Thoracic cage anomaly (unspecified); other chondrodystrophy; osteogenesis imperfecta; fragilitas ossium
756.520;.530	Chondroectodermal dysplasia; infantile cortical hyperostosis
756.56–.57;758.58–.59	Osteopoikilosis; multiple epiphyseal dysplasia; other osteodystrophies
756.710–.72	Gastroschisis; prune belly syndrome
756.80–.81	Polands syndrome; other absent or hypoplastic muscle
756.84–.86	Amyotrophia; Ehlers-Danlos; congenital torticollis
757.115–.30	Congenital ichthyoses; abnormal palmar creases; other skin anomaly
757.37–.50	Cutis laxa hyperelastica; skin absent; hair anomaly; absent nails
757.58;.68	Hypoplasia fingernails or toes; other gonadal dysgenesis
759.00–.19	Anomaly of spleen or adrenal gland
759.23–.49	Endocrine gland (other); situs inversus; conjoined twin
759.60–.69	Hamartomas
759.89–.99	Probable other specified anomaly; embryopathia; congenital anomalies not otherwise classified

[1] British Pediatric Association modification of ICD–9–CM, as modified by the Division of Birth Defects and Developmental Disabilities, Center for Environmental Health and Injury Control, Centers for Disease Control, Atlanta, GA.

ratings, reflecting rater discordance primarily for rare birth defects. Table 2 displays the distribution of the study population as to the probability of mental retardation; a small effect of rater discordance can be seen within each probability range.

Table 3 depicts the range of MR probability estimates derived from various combinations of probability ratings and paradigms for handling multiple birth defects. Estimates for numbers of children with MR were computed in two ways. First, the probabilities were computed using a probability of 0.05 for infrequent conditions, with a range based on separate estimates for conditions with rater discordance. Second, the probabilities were recomputed taking the extreme minimum and maximum probabilities for each condition across the two raters. The latter estimates are referred to as the 'overall minimum estimate' and the 'overall maximum estimate' in table 3.

Data on school enrollment and children defined as mentally retarded participating in special education in school districts in the study area are given in table 4. The number of children roughly drawn from this birth cohort that were ages 6–8 and were classified as mentally retarded by the Special Education Division of the Arkansas Department of Education for the school year 1988–89 was 747. As shown in the table, the MR prevalence estimate from cases of birth defects accounts for 32 to 56 percent of the MR prevalence in the public schools.

Discussion

It is known that birth defects contribute significantly to fetal loss (*10,11*), low birth weight (*12*), infant mortality (*13,14*), and child mortality (*15,16*). In addition, it has been suggested that the number of newborn minor physical anomalies correlates with the child's developmental score at age 5 years (*17*) and with short attention span, peer aggression, and impulsivity at age 3 (*18*). To our knowledge this is the first report that has used data from the surveillance of birth defects to predict the prevalence of mental retardation within a defined population. Since many States have established birth defects registries, analyses of data such as those we have reported may prove to be an attractive method of finding and tracking children in need of educational services. Our findings suggest that a State birth defects monitoring system will identify many children who may benefit from early intervention.

Determination of the relative contribution of prenatal, perinatal, and postnatal factors in the etiology of neurodevelopmental abnormalities has been difficult to assign with accuracy. In this study, as in most others, the causes of mental retardation have been inferred from population data. Many conditions, such as Down syndrome, are assumed with a high degree of accuracy to be causative of the mental retardation, whereas other conditions, particularly single defects of presumed

Table 2. Effect of inter-rater differences regarding probability estimates of mental retardation upon the number and distribution of cases of birth defects in 28 Arkansas counties

Estimated probability of mental retardation	Minimum		Maximum	
	Number	Percent	Number	Percent
0.00	222	14.7	206	13.7
0.05–0.15	979	65.0	967	64.2
0.16–0.33	108	7.2	115	7.6
0.34–0.49	0	0.0	10	0.7
0.50–0.79	67	4.4	76	5.0
0.80–1.00	130	8.6	132	8.8
Total	1,506	100.0	1,506	100.0

Table 3. Number of children with mental retardation (MR) predicted from a review of cases of birth defects in 28 Arkansas counties

Estimate type	Number of children	
	Single highest MR probability per case	Sum of all MR probabilities per case
Probability for infrequent conditions = 0.05	[1]247–254	[1]267–274
Probability for infrequent conditions = 0.15	345–350	396–401
Overall minimum estimate[2]	243	263
Overall maximum estimate[3]	354	405

[1] Range due to rater discordance.
[2] Probability for infrequent conditions set at 0.05 and minimum rating of discordant pairs.
[3] Probability for infrequent conditions set at 0.15 and maximum rating of discordant pairs.

multifactorial etiology such as cleft lip and palate, are almost certainly not causal, but rather temporal in their relationship. Previous studies have attempted to distinguish between severe and mild mental retardation in assigning risks attributed to birth defects. While prenatal factors have been found to account for about 50 percent of cases of severe mental retardation, they account for no more than 25 percent of cases of mild mental retardation (*19*). In this report, no distinction is made between mild and severe mental retardation. The relationship of a particular anomaly to mental retardation is, in most cases, not known with accuracy, so that an assignment of risk involves a consideration of the range of conditions which might be associated with that particular anomaly.

Rater discordance had little effect on the number of children from the study cohort predicted to have mental retardation; it affected less than 3 percent. As illustrated in table 2, only 14 percent of the children with one or more birth defects were estimated to have no association with MR; 8–9 percent were estimated to have very high likelihood of association with MR. Children having birth defects with a low probability estimate comprised 65 percent of the study cohort. As data on the likelihood of an association with MR for these birth defects are generally lacking, the assigned 5–15 percent probability range strongly affects the predicted MR case number; table 3 demonstrates this effect. This table also illustrates the effect of two approaches to consideration of children with multiple birth defects. The maximum estimate of the proportion that were MR related increased from 47 to 56 percent of birth defects cases when multiple problems were considered to be additive, again reflecting the strong influence of defects that had high prevalence, but a low probability of being MR related.

The case rate of birth defects for the 28-county Arkansas area during 1980–82 was 31 per 1,000 live births. This rate can be compared with that for metropolitan Atlanta, 3.4 percent, ascertained by the Metropolitan Atlanta Birth Defects Monitoring Program (CDC) for 1980–85 (personal communication from Larry D. Edmonds, CDC, February 13, 1987), and to that for much of the State of California, 2.7 percent (*20*), ascertained by the California Birth Defects Monitoring Program for the years 1983–86. These programs have case ascertainment methods similar to those employed in this Arkansas study. The case rate of birth defects does not include minor anomalies unlikely to be ascertained in hospitals or in Head Start Programs. Because these anomalies are not commonly associated with MR, they are thought to have little effect on the predicted prevalence of MR.

In- or out-migration of children with birth defects or developmental disabilities could have occurred during the interval from birth to school age. Although families with young children are known to be highly mobile, we are unaware of any reports that document a higher mobility for families with children who have special health care needs. Within the State of Arkansas, services for persons with birth defects are most available within the 28-county study area. Although in- or out-migration undoubtedly does occur, it is more likely that families with affected children would migrate into the study area. Therefore, any bias due to net migration increases the denominators in our computations, and it is unlikely to affect the findings of our study in any significant manner.

The prevalence of MR in public schools for this cohort of 6- to 8-year-olds was 14.5 per 1,000 compared with 7.85 per 1,000 for the nation in 1988–89. Patrick and Reschly (*21*) reported a wide range of MR prevalence from State school systems;

higher prevalence is generally found in southern States and is most closely related to parental median educational level. Studies reviewed by McLaren and Bryson (*19*) estimated the prevalence of MR to be 6–8 per 1,000 population and to be highly dependent on ascertainment method, sex, and age. The prevalence of MR in childhood may also be associated with rurality and levels of socioeconomic status in the community. The prevalence of school-recognized MR increases strongly with age until the teen years (*9,22*), but MR associated with cases of birth defects is likely to be diagnosed early and does not increase appreciably with age. The proportion of children in public school with MR predicted by prevalence estimates derived from birth defects data is therefore anticipated to be somewhat high, due to late diagnosis of MR within the school system (that is, the denominator increases with age).

Conclusion

The data presented in this study suggest that children with malformations and their sequelae represent a significant proportion of the population with neurodevelopmental handicaps. Recognition of this association is helpful in predicting the number of persons who might have preventable causes of disability, in anticipating the special educational needs of affected children, and in planning for provision of special services within a given population. It is possible that early recognition of the association of MR with specific birth defects, along with early aggressive therapeutic treatment, may ameliorate to some extent this birth defect sequela. For conditions that are relatively common and contribute significantly to the overall prevalence of MR, such as cleft lip or cleft palate or both, we recommend that a multidisciplinary approach to assessment and longitudinal care, including developmental evaluation and referral, be part of the health care supervision of affected children.

Objectives for the Healthy People 2000 goals include broader multidisciplinary evaluation for persons with cleft lip or cleft palate or both (*23*). A similar approach could be instituted for children with congenital heart defects, neural tube defects, and other selected malformations. Children with MR not attributable to birth defects should be further studied to identify possible associated risk factors. Although infants with birth defects later constitute a significant proportion of the population with mental retardation in schools, early intervention activities based solely on this source to find children will fail to identify the majority of children later determined to have a developmental disability.

Table 4. Public school data for 1988–89 on enrollment and number of children with mental retardation (MR) in 28 Arkansas counties

Category	Number or range
Group	
Children ages 6–8 with MR (IQ less than 70)	747
Children ages 6–8 enrolled in school	51,689
Estimate type	
Proportion of MR predicted from birth defects data:	
Using the single highest MR probability	0.32–0.47
Using the sum of all MR probabilities	0.35–0.56

SOURCE: Special education and school enrollment data obtained from the Division of Special Education, Arkansas Department of Education.

As many States have already established birth defects registries, this may be an attractive child find method. The potential use of data in a birth defects registry for planning of developmental services has been suggested (*1–3*). These data may be especially beneficial in providing estimates of the demand for early intervention services under Public Law 99–457, Part H of the Individuals with Disabilities Education Act (*24*), and the appropriateness of perinatal risk factors as biological and environmental markers of risk for developmental delay (*25,26*).

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