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Assessing chances of hospital admission in preschool children*

Critical evaluation

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SUMMARY In discussing social class differentials in childhood mortality and morbidity a recent report on the British child health services suggests that it is possible to identify children at risk, and a government publication has indicated that health visitors (community nurses) could do this. The National Survey of Health and Development, a longitudinal study of over 5000 children regularly investigated from birth so far to age 31 years, gives an opportunity to test the usefulness of these propositions, since it has complete illness records of the study population and health visitors' assessments of their home circumstances, maternal care, and use of child welfare services.

This study shows that these assessments were not particularly successful in identifying children at risk of hospital admissions for certain illnesses, even when more than one hospital admission or a serious illness later occurred. The maximum reduction of hospital costs by such identification would be little better than one-third and there would be an unquantifiable, but very real, stress imposed on families in which children were wrongly identified as at risk. It is suggested that further development of health visitors' work as family nurses would give a more effective form of child health care by providing greater sensitivity of surveillance, by involving parents in preventive care, and by making appropriate use of health visitors' skills.

There can be little doubt that illness in the first 5 years of life is of particular significance. Risk of death is higher than at any other time in childhood, and evidence is accumulating that illness at this time may have a long-term effect, not only on the health of the adolescent and young adult (Colley *et al.*, 1973; Kiernan *et al.*, 1976) but its treatment may in some cases affect later behaviour (Douglas, 1975). The recent consultative document on the future of the personal health and social services in England points out that 'perinatal and pre-school years . . . are of crucial importance for the child's later development' (para 9.4), and notes 'the need to avoid keeping children in hospital for long periods' (para 9.7) (Department of Health and Social Security, 1976). Clearly, prevention is the appropriate strategy, and it is important to ask, how far is it helpful to go into the business of primary prevention?

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Prevention at all levels is based on the knowledge of risk factors, and for some conditions and at some times in life much is known of such factors. For example, risk factors for perinatal mortality are well defined (Butler and Bonham, 1963), and the use of risk factors in the selection of a particularly high-risk group, such as those at risk of handicap, has also been described and evaluated (Alberman and Goldstein, 1970).

The Court Report (Department of Health and Social Security *et al.*, 1976) observed that a 'child born into the family of a semi-skilled worker is twice as likely to die between the end of the first month and the first year of his life . . . as a child born to parents in social classes I and II' (p.6), and also reminds us that,

> '. . . disadvantage is not determined by class alone. Disadvantaged children are more likely to be born to young mothers who are less likely to have used the antenatal services and are more likely to have smoked heavily during pregnancy. They are more likely to be born prematurely and have a low birthweight. In the early days and

weeks of life they are more exposed to the risk of infection and death. Evidence to this Committee suggests that it is largely possible for this group to be identified.' (pp.6–7).

But whereas the search for risk factors in the first 6 months of life has been fairly successful for certain conditions, these conditions are not the commonest, nor has the identification of risk factors during the subsequent childhood years been very helpful. Nevertheless, the Court Report asserts that 'much ill-health in children is preventable' (para 12.2), and notes that 'much of the illness coming to primary care has a strong psycho-social element' (para 12.5). Could it be that the social characteristics of those consulting medical care would provide some useful identifying factors for the early identification of children who are most likely to require care?

A keystone of future plans for the identification of children who are most at risk of illness seems to be 'expansion of the health visiting service, with its crucial role in protecting the health of the most vulnerable children and bringing to notice cases of neglect and ill-treatment' (Department of Health and Social Security, 1976 para 9.25). If health visitors are to 'protect' the health of the most vulnerable they will need to have certain signs or indicators to look for in order to identify this group.

If identification is carried out by way of a thorough knowledge of families as advocated by the Court Report (paras 12.8, 12.9) the number of health visitors needed to spend sufficient time 'for regular contact between parents and members of the health care team' would be considerable. On the other hand, identification by systematic assessment of information routinely collected on every child might also be expensive, especially if collecting and processing information had to be a special exercise. Obviously any information (such as social class) which has to be coded, or which can only be collected by general population survey or a private census is impractical, for reasons of time and cost. We report an assessment of the yield of children at risk of illness identified by systematically collected information. The information used has been restricted to that which would be readily available to health visitors now. The cost effectiveness of this procedure is also examined.

Method

An opportunity exists to test the practicality of such a scheme by way of the National Survey of Health and Development. It is a prospective nationwide survey of 5362 children, comprising all the single, legitimate live births in the week 3rd to the 9th March, 1946 to wives of nonmanual and agricultural workers, and 1 in 4 of similarly defined births in the same week to wives of all other manual workers. The selection of 1 in 4 of manual workers' children can be compensated for by statistical weighting of results. This population of children has been studied at intervals of not less than 2 years since their birth up to the age 26 years, and the investigation is continuing. An outline of the study's current work may be found in Douglas (1976) and in Douglas *et al.* (1977).

During the children's preschool years health visitors and district nurses collected information about the family circumstances and the index child's health when the child was aged 8 weeks, and again at 2 years and at 4 years. They also assessed certain aspects of the mother's care of this child. Mothers also gave information about children's admissions to hospital and details were checked with hospitals. From these data information has been selected which, although especially collected for this study, would be easily available in *everyday practice* to health visitors. A group of children was defined for these purposes, as having been admitted to hospital between birth and their fifth birthday with illnesses which were likely to be associated with the kind of information routinely available to health visitors, and in which early intervention was judged likely to be profitable. These decisions were made about types of illnesses and not on knowledge of individual cases, and these disorders, which are now referred to as the 'preventable' conditions, are listed in Table 1. One or more of these illnesses was experienced by 754 children by their fifth birthday (Table 2).

Table 1 *Admissions to hospital between birth and the fifth birthday for illnesses judged to be preventable. Diseases are grouped according to the International Statistical Classification (WHO, 1948)*

ISC code	*ISC disease group*	*No.*	*No. of admissions per 1000 live births*
1–138	All infective and parasitic diseases	210	39·2
280– 89	Avitaminoses and other metabolic diseases	2	0·4
291	Iron deficiency anaemias	1	0·2
340– 5	Inflammatory diseases of the CNS	5	0·9
370– 9	Inflammatory diseases of the eye	4	0·7
390– 96	Diseases of the ear and mastoid process	77	14·4
470–527	Diseases of the respiratory system	411	76·7
530– 35	Dental disease	1	0·2
571– 2	Gastroenteritis and colitis	34	6·3
590–609	Nephritis, nephrosis, and other diseases of the urinary system	19	3·5
690–716	Disease of the skin and cellular tissue	21	3·9
763– 65 & 767– 68	Birth injuries, asphyxia, and infection of the newborn	12	2·2
772– 73	Nutritional maladjustment and ill-defined diseases peculiar to early infancy	12	2·2
800–996	Accidents, poisoning, and violence	93	17·3

Table 2 *Admissions to hospital between birth and the fifth birthday*

	Total population	*Not admitted to hospital at this age*	*Admitted to hospital, but not with 'preventable' illness*	*Admitted to hospital with 'preventable' illness*
No.	5362	4107	501	754
%	100·0	76·6	9·3	14·1

Findings

Identification of risk factors. Table 3 lists information among which risk factors were sought by examination of associations between each item of information and hospitalisation for preventable conditions. Table 4 shows that these children were significantly more likely to live in families classified as manual social class, and other associations showed this too.

Table 3 *The four sets of factors used in the analysis*

Family structure and home circumstances
- Social class (derived from father's occupation when the child was aged 4 years and coded using the Family Census of 1946)
- Mother's education—final level achieved
- Mother's age at birth of this child
- Mother's age at marriage
- No. of children in the household when this child was aged 4 years
- Birth order of this child
- Whether the family had been broken by divorce, separation, or parental death by the time this child was aged 4 years
- Whether or not the home was owned

Health visitor's assessments made when the child was aged 4 years
- Of the cleanliness of the house
- Of the state of the child's footwear
- Of the state of the child's clothes
- Of the cleanliness of the child
- Of the mother's willingness to accept advice
- Of the mother's management and understanding of the child

Records of services used (compiled by health visitors)
- The number of these services used—antenatal care, postnatal care, and diphtheria immunisation of the child
- No. of infant welfare attendances in the child's first year of life

Birth circumstances
- Birthweight

Table 4 *Comparison of the social class of fathers of children hospitalised for preventable illness between birth and their fifth birthday with all other children*

	Social class of father	
	Nonmanual	*Manual*
Children in hospital with 'preventable' conditions	10·4 (133)	15·1 (615)
All other children	89·6 (1142)	84·9 (3457)
Total (= 100%)	(1275)	(4072)

$\chi^2 = 17{\cdot}23$ with 1 df $P<0{\cdot}001$.

Health visitors significantly more often rated the hospitalised children as among the least clean, as more often having clothes in an unsatisfactory state of repair, and their mothers were more often scored with the worst maternal management score. In terms of family structure they more often came from large families, and were themselves more likely to be 3rd or later born children, and they more commonly lived in poor accommodation. Their mothers less often used antenatal care, postnatal care, or had their children immunised against diphtheria. They were, in short, a socially quite visible group. These findings were used in a discriminant analysis to rank children according to the extent to which this information classified them as at risk of having a preventable illness so that the success of identification of the children actually hospitalised with such conditions could be established.

Use of risk factors in prediction. Table 5 shows the rates of prediction obtained when information on this population of children was used to predict which ones would be hospitalised between birth and their fifth birthday, and it is clear that, as the numbers of false positives and false negatives show, it is not a very successful prediction. In epidemiological terms the sensitivity of this identification was 59.8% (i.e. the percentage of hospitalised children identified) and the specificity 51.6% (i.e. the percentage of non-hospitalised children identified). We tried to improve on these disappointing findings by selecting only the top 20% of the whole population, that is the 20% most at risk. However, even this showed that only 27% of all hospitalised children were to be found in this segment of the whole population.

The procedure already described was repeated, but this time to try to distinguish those children first admitted to hospital for any reason between ages 5 and 11 years. The results were moderate but not spectacular, identifying correctly 62.1% of hospital admissions and 45.7% of those not admitted. There was a little improvement with increasing numbers of admissions, and whereas 58.4% of first admissions were correctly identified, the percentage of second admissions was 64.4%, and of third admissions 68.8%.

The data were also not particularly helpful in the correct identification of those with specific illnesses.

Table 5 *Results of the discriminant analysis showing actual and predicted hospitalisation*

	Predicted as hospitalised	*Predicted as not hospitalised*
Actually hospitalised	303	204
Actually not hospitalised	1440	1535

Of the 108 children for whom information on all the risk factors was available and who were diagnosed as asthmatic by age 15 years, 47 were correctly distinguished as sick and 61 were incorrectly classified as fit; similarly 9 polio victims were correctly identified and 11 missed, and 17 children with speech defects were identified and 12 missed.

Cost of hospital admission. Could it be that despite the relatively low predictive value of these data they were, in fact, selecting out the children who experienced the longest, and therefore the most costly, hospital stays? By using the DHSS's information on the cost of hospital stays in all English and Welsh regions for 1951–1952, Table 6 shows that although admissions for illnesses designated as preventable accounted for as much as 71% of the total cost, the maximum saving that would have been achieved if all the correctly identified hospitalised children had not been admitted to hospital was 35%. Although savings of this order would be welcome and would have the additional advantage of preventing a child experiencing hospital admission, nevertheless alternative forms of treatment are not costless, although for want of cost data they have not been taken into account. Nor was it possible to say how much it would have cost to carry out surveillance of the false-positive group, that is those who were wrongly identified as hospitalised. Similarly, it was impossible to compute a notional cost of the strain on families of having a child admitted to hospital, or of having a child classified as at risk.

Discussion

At first sight these findings may seem disappointing, and not very helpful in identifying sick children, or in achieving a satisfactorily low percentage of children wrongly identified as sick, or in achieving a significant cost saving. However, these factors do seem to have had a degree of success comparable with that of at-risk registers. At-risk registers have not been conspicuously successful largely because the range of at-risk criteria normally used has been found to apply to 60% or more of all children (Oppé, 1967), whereas a level of 20% had been anticipated (Sheridan, 1962). Such high percentages of children selected as at risk, of course, negate the potential usefulness of surveillance, because of the overwhelming numbers. This reason can appropriately be said to have contributed to the findings of the present study, and maybe there were other reasons.

Perhaps the social factors used were the wrong ones; but in fact little else could be *readily* available for all families with children. Perhaps the obstetric data, which consisted here only of birthweight, were not enough; but most other obstetric factors associated with a poor prognosis also present together with low birth-weight, low social class, and large family size. Perhaps, of course, the population of the National Survey of Health and Development is not representative, and is somehow biased in its experience of illness. This is unlikely, since comparison with other studies and with official population statistics shows it to be representative of many illnesses, as well as of certain social factors such as marriage, divorce, and crime rates (Pless and Douglas, 1971; Wadsworth and Jarrett, 1974).

The fact is that illness in children from the second year of life onwards is not likely to be associated with such crude measures of life style as social class, or family size, or the kinds of things that could easily be collected by health visitors in the course of their work. It is associated with things in the social environment which require much finer instruments to detect, as recent aetiological research in some conditions, such as accidental injury, shows.

Both the work on at-risk registers and the findings of this study show that without extra expenditure on collecting more sensitive data health visitors are not going to be able to establish grades of risk for the whole population that will allow economically viable detection of individuals who require care. Perhaps, therefore it will be better not to use nursing skills in the essentially clerical task of establishing at-risk registers of vulnerable children, but rather to allow health visitors to develop their 'role as a child and family nurse in health and illness' since 'her

Table 6 *Cost of admissions* to hospital between birth and the fifth birthday of the English and Welsh children*

	1946/7	*1947/8*	*1948/9*	*1949/50*	*1950/51*
Total costs £.np	7862·72	5941·78	8440·31	9379·44	10162·45
Cost per capita for the survey's English and Welsh population in these years (n = 4367) £.np	1·80	1·36	1·93	2·15	2·33
Estimate of 'preventable' illness admissions costs £.np (% of total cost)	4845 (61·62)	4222·27 (71·67)	5964·97 (70·67)	8096·94 (81·96)	6726·97 (66·19)
Percentage of total costs saved if correctly predicted admissions for 'preventable' illness had prevented admission	20·9	21·5	19·3	29·1	35·1

*Costs were computed for each year 1946/51 using information from the Hospital Costing Returns 1951/52 (Ministry of Health, 1953), the British Labour Statistics Historical Abstract 1866–1968 (Department of Employment, 1971) by deflating the 1950/51 figures back for every year.

access to the child in his home gives her unique and essential opportunities to observe young children in their natural environment' (Department of Health and Social Security *et. al.*, 1976). The adoption of this role by health visitors would, as the Court committee suggests, not only form a sensitive method of surveillance but also be the beginnings of a way to involve parents in this and other preventive aspects of the health care of their children. It would also make good use of health visitors skills, with appropriate consideration for their morale.

In fact, many general practitioners and health visitors with experience of close and fairly regular observation of children and parents would probably feel that establishing vulnerability or a condition of being at risk is relatively easy, given appropriate opportunities for close contact and home visiting. Research is now much more urgently required in what to do about the children identified as at risk.

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