Infantile hypertrophic pyloric stenosis in South Glamorgan 1970–9

Effects of changes in feeding practice

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SUMMARY In a retrospective analysis of cases of surgically confirmed infantile hypertrophic pyloric stenosis (IHPS) in South Glamorgan in the decade 1970–9 the incidence rose sharply in 1976 reflecting a general increase reported throughout Wales and from other parts of the United Kingdom. The increase was mainly among boys and although it occurred at a time when breast feeding had become more popular, it affected bottle fed infants more than breast fed infants. The apparent correlation between incidence of IHPS and incidence of breast feeding may be coincidental and changes in infant milk formulae that became general in 1976 may be more important. An appreciable excess of first born infants with IHPS was noted but there was no correlation between birthweight and IHPS. Variations according to month of birth did not coincide with true seasonal variation.

Although the definitive cause of infantile hypertrophic pyloric stenosis (IHPS) is unknown, several predisposing risk factors are associated with the condition. Various genetic models have been proposed but there can be no doubt that these are modified by environmental factors such as:

- (1) birth rank—an excess of first borns were found to have had a Ramstedt's operation;
- (2) social class—affected infants more often came from families in higher social classes than would be expected;
- (3) seasonal variation in incidence—IHPS was more common in winter months with a peak incidence in March;
- (4) feeding—a slightly higher proportion of breast fed infants than controls had IHPS, although the incidence of breast feeding in the population was low and falling rapidly at the time of the study.¹

A correlation between birthweight and IHPS has been documented.^{2,3} Although Adelstein and Fedrick denied positive correlations between IHPS and birthweight and IHPS and first borns, they did, however, show a seasonal variation of incidence with a peak in July.⁴

Our purpose was to examine some of these environmental factors during a period in which the incidence of IHPS rose substantially and was

thought to be rising—an impression that proved to be correct.

Materials and methods

We surveyed retrospectively cases of surgically confirmed IHPS whose home address at the time of their pyloromyotomy was in South Glamorgan. Few if any confirmed cases of IHPS are treated by medical means in this area but the existence of mild undiagnosed cases obviously cannot be ruled out. Treatment policies did not change, however, during the study period.

The area of South Glamorgan (estimated mid year population for 1979, 390 600) has been well defined since 1 April 1974, and between 1970 and 1979 (inclusive) there were 53 832 live births in South Glamorgan or its equivalent area (Office of Population Censuses and Surveys). There are 2 hospitals in the area that care for infants with IHPS—Llandough Hospital and the University Hospital of Wales (since 1972). There were 115 cases in South Glamorgan or equivalent area before 1974 and these were found by searching the operating registers at these hospitals. Comparison data for birth rank, birthweight, month of birth, and method of feeding were obtained from the Cardiff birth survey by examining data on 44 539 live births to mothers whose home addresses were in South Glamorgan or

Cardiff (before the 1974 boundary change). For analysis of these data in the IHPS group, 17 cases were excluded who lived outside Cardiff before the 1974 boundary change and a postal questionnaire was sent to the parents of the remaining 98 cases.

Information obtained by questionnaire included birth rank (defined as order of birth of patient and previous live born siblings), birthweight, method of feeding, duration of breast feeding, and addition of bottle supplements where applicable. Sixty four percent of questionnaires were returned and in the remaining 36% information was obtained as accurately as possible from the child's medical and neonatal records and the mother's obstetric records.

Results

Incidence. The incidence of IHPS has varied over the past 10 years in South Glamorgan. Annual records indicate a sudden increase in 1976 that was maintained in the succeeding 3 years (Table 1). The mean incidence before 1976 was 1.4/1000 live births and after 1976 3.4/1000 live births. This difference was highly significant ($P < 0.0001$) representing a real change in the incidence of IHPS in 1976. Further supportive evidence is given in the Figure where a

proportional distribution test has been used to show the expected range of incidences assuming a mean incidence of 1.4/1000 live births. The separate contributions of boys and girls to the variation in incidence are given in Table 2. Two yearly variations

Figure Incidence of infantile hypertrophic pyloric stenosis in South Glamorgan 1970-9.

The shaded area represents expected range of incidence assuming a mean of 1.4 cases /1000 live births per year.

Table 3 Distribution of infantile hypertrophic pyloric stenosis (IHPS) cases in South Glamorgan (Cardiff before 1974) by month of birth over the period 1970-9

Month	Live births	IHPS births*	Incidence/1000 live births
January	3620	11	2.4
February	3444	8	2.3
March	3930	8	2.0
April	3607	9	2.5
May	3954	10	2.5
June	3570	11	3.1
July	3700	5	1.4
August	3682	7	1.9
September	3549	7	2.0
October	3605	8	2.2
November	3379	5	1.5
December	3399	13	3.8

*5 cases included who were born in 1979 but operated on in 1980.

Edwards's test $\chi^2 = 9.9$; df = 2; $P < 0.01$

$\theta^\circ = 84^\circ 28'$ and $269^\circ 28'$

Maximum early April

Minimum early October

$1 + a/1 - a = \text{max/min} = 2.57$.

Table 1 Incidence of infantile hypertrophic pyloric stenosis in South Glamorgan 1970-9

Year	Live births	Pyloric stenosis	Incidence/1000 live births
1970	6647	8	1.2
1971	6628	14	2.1
1972	6108	12	2.0
1973	5734	9	1.6
1974	5145	4	0.8
1975	4639	3	0.7
1976	4730	14	3.0
1977	4450	16	3.6
1978	4681	17	3.6
1979	5070	18	3.6
Total	53 832	115	2.2

Mean incidence 1970-5 1.4/1000 live births; mean incidence 1976-9 3.4/1000 live births. $\chi^2 = 23.1$, $P < 0.0001$; $\chi^2 = 22.8$ (Yates's correction).

Table 2 Two yearly incidence of infantile hypertrophic pyloric stenosis (IHPS) in South Glamorgan

Years	Boys and girls*			Boys†			Girls‡		
	Live births	IHPS	Incidence	Live births	IHPS	Incidence	Live births	IHPS	Incidence
1970-1	13 275	22	1.7	6 793	19	2.8	6 482	3	0.5
1972-3	11 842	21	1.8	6 110	11	1.8	5 732	10	1.7
1974-5	9 784	7	0.7	5 098	4	0.8	4 686	3	0.7
1976-7	9 180	30	3.3	4 603	25	5.4	4 577	5	1.1
1978-9	9 751	35	3.6	4 985	24	4.8	4 766	11	2.4
Total	53 832	115	2.2	27 589	83	3.1	26 243	32	1.3

* $\chi^2 = 26.6$, $P < 0.001$; † $\chi^2 = 25.9$, $P < 0.001$; ‡ $\chi^2 = 10.4$, $P < 0.05$.

Table 4 Distribution of infantile hypertrophic pyloric stenosis (IHPS) cases in South Glamorgan (Cardiff before 1974) by birth rank compared with distribution of 43 464 live births over the period 1970-9

Birth rank	Live births	IHPS	Boys IHPS	Girls IHPS
	No (%)	No (%)	No (%)	No (%)
1	17 814 (41.0)	51 (52.0)	41 (56.2)	10 (40.0)
2	14 348 (33.0)	29 (29.6)	17 (23.3)	12 (48.0)
3	6 629 (15.3)	12 (12.2)	9 (12.3)	3 (12.0)
4	2 790 (6.4)	3 (3.1)	3 (4.1)	0
5	1 883 (4.3)	3 (3.1)	3 (4.1)	0
Total	43 464* (100.0)	98 (100.0)	73 (100.0)	25 (100.0)

*Birth rank unknown for 75 live births in South Glamorgan
IHPS in first borns: IHPS in others $\chi^2 = 4.9$
 $\chi^2_{\dagger} = 4.8$ } $P < 0.05$

Boy : girl IHPS first borns $\chi^2 = 1.9$
 $\chi^2_{\dagger} = 2.0$ } $P > 0.1$

†Yates's correction.

Table 5 Birthweight distribution of infantile hypertrophic pyloric stenosis (IHPS) cases in South Glamorgan (Cardiff before 1974) 1970-9, compared with live births

Birthweights (kg)	Live births	IHPS
	No (%)	No (%)
<1.9	1 013 (2.3)	1 (1.0)
2.0-2.4	2 296 (5.3)	7 (7.1)
2.5-2.9	8 531 (19.6)	26 (26.5)
3.0-3.4	17 090 (39.3)	33 (33.7)
3.5-3.9	11 065 (25.5)	24 (24.5)
4.0-4.4	3 016 (6.9)	7 (7.1)
>4.5	458 (1.1)	0
Total	43 469* (100.0)	98 (100.0)

*Birthweight unknown for 70 South Glamorgan live births
 $t = 0.01$; $df = 43\ 565$; $P > 0.9$.

Table 6 Comparison of infantile hypertrophic pyloric stenosis (IHPS) cases and South Glamorgan (Cardiff before 1974) live births for method of feeding at 1 week

Years	South Glamorgan live births			IHPS cases		
	Live births (No)	Wholly or partly breast fed at 1 week No (%)	Not breast fed at 1 week No (%)	IHPS cases No (%)	Wholly or partly breast fed at 1 week No (%)	Not breast fed at 1 week No (%)
1970-1	8 620	2 024 (23.5)	6 596 (76.5)	12 (1.4)	5 (41.7)	7 (58.3)
1972-3	7 732	1 972 (25.6)	5 756 (74.4)	14 (1.8)	3 (21.4)	11 (78.6)
1974-5	8 269	2 750 (33.3)	5 519 (66.7)	7 (0.8)	3 (42.9)	4 (57.1)
1976-7	9 142	4 134 (45.2)	5 008 (54.8)	30 (3.3)	12 (40.0)	18 (60.0)
1978-9	9 776	4 871 (49.8)	4 905 (50.2)	35 (3.6)	16 (45.7)	19 (54.3)
Total	44 139	15 773 (35.7)	28 366 (64.3)	98 (2.2)	39 (39.8)	59 (60.2)

For incidence of IHPS/1000 live births versus incidence of breast feeding $r = 0.83$

Incidence of IHPS in breast fed sample 1970-5, 1.63%; 1976-9, 3.11%

$\chi^2 = 3.41$
 $\chi^2_{\dagger} = 3.02$ } $P > 0.05$

Incidence of IHPS in formula fed sample 1970-5, 1.29%; 1976-9, 3.73%

$\chi^2 = 17.54$
 $\chi^2_{\dagger} = 18.27$ } $P < 0.001$

*Yates's correction.

in incidence are shown owing to the small numbers and it is clear that the change in incidence is accounted for mainly by a variation in the incidence of IHPS among boys ($P < 0.001$).

Seasonal variation. Table 3 shows IHPS incidence by month of birth. Edwards's test for cyclical trends⁵ has been used and gives a significant cyclical variation ($P < 0.01$) with a peak incidence in early April and a minimum incidence in early October. The ratio of maximum to minimum incidence is 2.57.

Birth rank. The 98 cases were compared with 43 444 live births in South Glamorgan (Cardiff before 1974) for birth rank (Table 4). The χ^2 test was used to compare the incidence of IHPS in first borns and others. There was an appreciable excess of IHPS in first borns and this was similar for both boys and girls.

Birthweight. Table 5 shows the distribution of birthweights for the 98 IHPS cases and 43 469 live South Glamorgan births. The mean birthweight for the IHPS cases was 3.197 kg and the mean birthweight for the South Glamorgan live births was 3.217 kg. A Student's two sample t test did not detect any significant difference between the birthweights of South Glamorgan live births and IHPS cases.

Feeding. Records of the period 1970-9 show that of 44 139 live births in South Glamorgan (Cardiff before 1974), 15 773 (35.7%) were breast fed at 1 week compared with 39 (39.8%) IHPS cases.

Table 7 Incidence of Ramstedt's operation on infants in Wales 1972-8

1972		1973		1974		1975		1976		1977		1978		1979		1980		1981	
M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
46	21	48	17	40	18	44	10	66	13	109	21	71	23	118	26	122	18	94	20

Source: Welsh Office, Hospital Activity Analysis.

The excess of breast feeding among the IHPS group was not statistically significant ($\chi^2_1 = 0.71$ (0.67 with Yates's correction), $P > 0.25$). Table 6 shows the 2 yearly variation in breast feeding for South Glamorgan (Cardiff before 1974) live births and IHPS cases. Although the incidence of IHPS seems to follow closely the incidence of breast feeding ($r = 0.83$), separate analysis of the breast fed and formula milk fed infants shows that there was no appreciable increase in incidence of IHPS in the breast fed group after 1976, and that the rise in IHPS at that time affected predominantly the bottle fed babies.

Discussion

The incidence of IHPS in South Glamorgan was low in the first few years of the study but is in keeping with Adelstein and Fedrick's observations in Oxford, where there was a mean incidence of 1.4/1000 live births between 1966 and 1971.⁴ The increase in IHPS in 1976 which has been sustained has been observed in other centres^{6,7} and in Wales as a whole (Table 7).

The increase in IHPS at a time when breast feeding had come back into fashion supports the theory that there is a contributory factor in breast milk¹ and there are indeed a number of possible candidates. For example, prostaglandins of the E and F series have been present in breast milk in concentrations over 100 times those found in adult plasma⁸ and oral prostaglandin E₂ increases both the strength and frequency of gastric antral contractions and the tone of the pylorus in puppies.⁹ This effect was similar to that of intramuscular pentagastrin, the stimulus used to produce an animal model for IHPS.¹⁰ The endogenous secretion of gut hormones is also affected by the method of feeding. Marked differences have been observed in hormonal responses to feeding between breast fed and formula fed infants with respect to the release of insulin, motilin, neurotensin, enteroglucagon, and pancreatic polypeptide.¹¹ Although an excess of breast fed babies with IHPS was reported before 1976,^{1,6} it did not reach statistical significance and became subsequently a slight deficit.

Some other environmental change must therefore

be found to explain the increase in IHPS. One of the factors that led to the resurgence of breast feeding was the publicity given to the dangers of unmodified cows' milk formulas and their abrupt withdrawal from sale in 1976. Although low solute 'humanised' formulas were substituted, they nevertheless differ from breast milk. Gastric emptying in infants is affected by the composition of the feed and is slower with an 'adapted milk formula' than with breast milk.¹² There is evidence that osmolality has an important effect on gastric emptying, in both adults¹³ and infants. In infants a high osmolar formula left the stomach more slowly than 2 other formulas with similar caloric density, lower osmolality, but additional differences in fat, carbohydrate, and protein composition.¹⁴ If the basic physiological abnormality in IHPS is incoordination between antral contractions and pyloric relaxation, this may become clinically evident more readily when the gastric emptying mechanism is speeded up relatively by a low osmolar feed than when it is slowed by fat or high osmolar feeds. The complex factors controlling gastric emptying make speculation easy and unequivocal studies difficult but the coincidence between the major change in British infant feeding that occurred in the second half of the 1970s and the marked increase in IHPS suggests a causal relation.

Seasonal variation in incidence has been noted in other studies^{1,3} but the times of maximum and minimum incidence do not coincide in any of these suggesting that where seasonal variation does exist it is caused by local factors that are as yet biologically unexplained.

Some workers^{1,3} have claimed an excess of higher birthweight infants with IHPS while others⁴ have denied this. In particular, the bias towards larger birthweight babies seen in 1 IHPS study may have reflected the larger proportion of higher social class babies and would also have been related, at the time of that study, to the proportion of infants who were breast fed.¹ The present study showed no variation in birthweight between IHPS and control groups.

We thank Dr Robert Newcombe for advice and help with statistical methods.

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Received 20 May 1983

British Paediatric Association

Annual meetings

1984	10–14 April	York University
1985	16–20 April	York University
1986	15–19 April	York University
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