

Data on the Etiology of Acute Intussusception in Childhood

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ACUTE INTUSSUSCEPTION in infancy and childhood is a condition of considerable clinical importance. Little is known of its etiology however; most of the relevant data have been obtained in the course of clinical investigation, and are unsuitable for examination of matters such as incidence, and its association with maternal age and birth order. An attempt was therefore made to assemble records of all infants and children in a large city who were treated for intussusception during a specified period. Data on all births in the same city were available from central records and from a $\frac{1}{200}$ th sample which has been fully described elsewhere (Record and McKeown, 1949).

MATERIAL

Survey of the records of all pediatric and general hospitals in the City of Birmingham, England, for the years 1945–54 revealed 296 confirmed cases of intussusception in Birmingham children under the age of ten years. (An additional 103 patients treated in Birmingham hospitals but resident outside the city boundary have not been included.) 230 of the 296 Birmingham children were treated in the Birmingham Children's Hospital and the remainder in general hospitals. The diagnosis was accepted only if confirmed at operation. Ten cases (7 male, 3 female) in which laparotomy revealed evidence of spontaneous reduction of a previously existing intussusception were included, but instances of supposed spontaneous reduction without laparotomy were not.

The type of intussusception was stated in the operation notes of 254 patients. 214 (84.3%) were of the ileo-caecal* or ileo-colic* variety and 31 (12.2%) were ileo-ileal. The remainder were colo-colic (7) and multiple (2). This distribution is similar to that noted in previous reports (Koch and Oerum, 1912; Close, 1931; Wakeley and Atkinson, 1938; Gross and Ware, 1948; Wansbrough and Cram, 1952).

The presence of a "leading point" to the intussusception was noted in only four cases—two of Meckels diverticulum (males, aged 3 months and 8 months), one of colonic polyp (male, aged $4\frac{1}{2}$ years) and one of jejunal polyp (male, aged 2 years). It is of course well recognised that acute intussusception in childhood can only rarely be attributed to such manifest local abnormalities (Koch and Oerum, 1912; Gross and Ware, 1948). In the present material one ileo-ileal intussusception in a boy aged 7 years was attributed to Henoch's purpura. There were three instances of recurrence, 3 months, 6 months and 2 years after the original operation. The last

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* No attempt is made to distinguish these two varieties since the criteria for their distinction are almost certainly not interpreted uniformly, and the difference between them is probably one of degree or duration rather than of etiology.

TABLE 1.—INCIDENCE OF INTUSSUSCEPTION IN BIRMINGHAM, 1945-54

Years	Number of Livebirths	Number Affected	Incidence (per 1000 live births)
1945-46	41,319	44	1.06
1947-48	44,530	46	1.03
1949-50	38,500	62	1.61
1951-52	36,955	75	2.03
1953-54	36,846	69	1.87
Total	198,150	296	1.49

case recurred for a second time 9 months after the second operation, an ileo-caecal intussusception being found on each occasion.

Information used in the following tables was obtained from three sources: (1) the hospital record (all cases); (2) interviews with the mothers during the year 1955 (212 cases); (3) the certificate of birth, obtained in the case of 30 patients who could not be traced in 1955. There remain 54 patients for whom information is limited to that recorded at the original hospital admission.

INCIDENCE

The numbers of patients with intussusception and the numbers of related livebirths are shown in Table 1. The incidence of intussusception was lower in the early years of this study than in the later years, but this observation may result from improved ascertainment. The total incidence for the ten year period (1.49 per thousand livebirths*) is considerably lower than the only other estimate of incidence; Spence and Court (1950) found 127 cases among 33,600 births (3.8 per thousand births) in Newcastle-on-Tyne in the years 1944-49. In the Newcastle material there was also a marked secular trend, 31 per cent of the cases falling in the first three year and 69 per cent in the last three.

AGE AND SEX

Distribution of the patients according to age, sex and type of intussusception is given in Table 2. The sex ratio (65.2% male) agrees closely with most previous estimates, for example 68% (Fitzwilliams, 1908; Koch and Oerum, 1912; Perrin and Lindsay, 1921), 64.4% (Hipsley, 1935), 63.9% (Close, 1931), and 63.8% (Wansbrough and Cram, 1952).

65.2% of the patients were under one year of age. This is in agreement with reports of representative material (Koch and Oerum, 1912; Perrin and Lindsay, 1921; Close, 1931) although data from pediatric or babies' hospitals (Hogg and Donovan, 1946; Wansbrough and Cram, 1952) naturally show a higher proportion of patients under 1 year. The distribution by month within the first year is fairly typical, although most reports suggest that the highest incidence is slightly later, for example

* It is not strictly correct to refer the number of cases of intussusception to the number of births in the period, since, of course, some of the older patients were born outside the period. Since 65% of the patients were under one year, however, the error is not large when a ten year period is used, and is certainly less than that involved in exclusion of patients not born within the period.

TABLE 2.—DISTRIBUTION ACCORDING TO SEX, AGE AND TYPE OF INTUSSUSCEPTION

Age at Operation (months)	Ileo-colic*			Ileo-ileal			Other			Unknown			Total		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
0-	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	1	—	1	—	—	—	—	—	—	—	—	—	1	—	1
2	1	3	4	—	1	1	—	—	—	—	1	1	14	5	28
3	10	11	21	—	1	1	1	1	2	3	1	4	14	14	28
4	14	17	31	2	—	2	1	—	1	3	—	3	20	17	37
5	13	9	22	1	1	2	—	—	—	4	1	5	18	11	29
6	11	9	20	—	—	—	—	—	—	4	2	6	15	11	26
7	7	7	14	1	—	1	—	—	—	3	1	4	11	8	19
8	10	8	18	—	—	—	—	—	—	2	—	2	12	8	20
9	4	1	5	2	1	3	1	—	1	2	—	2	9	2	11
10	4	2	6	1	—	1	1	—	1	1	1	2	7	3	10
11	4	—	4	1	—	1	—	—	—	1	—	1	6	—	6
12-	21	9	30	2	—	2	—	—	—	5	1	6	28	10	38
24-	17	3	20	6	2	8	1	—	1	2	—	2	26	5	31
36 and over	12	6	18	8	1	9	3	—	3	2	2	4	25	9	34
Total	129	85	214	24	7	31	8	1	9	32	10	42	193	103	296

* Includes ileo-caecal.

TABLE 3.—SEX RATIO (PER CENT MALE) ACCORDING TO AGE AND TYPE OF INTUSSUSCEPTION

Age	Ileo-colic*	Ileo-ileal	Other and Unknown Types	Total
0-8 mos.....	51.1 (131)	57.1 (7)	75.0 (28)	55.4 (166)
9 mos. and over.....	74.7 (83)	83.3 (24)	82.6 (23)	77.7 (130)
Total.....	60.3 (214)	77.4 (31)	78.4 (51)	65.2 (296)

* Includes ileo-caecal.

at 5 months (Perrin and Lindsay, 1921; Close, 1931) or 6 months (Fitzwilliams, 1908; Hipsley, 1935; Wakeley and Atkinson, 1938). It should be noted that in the present material age is calculated from date of birth, and a child aged 4 months and 29 days is classified as aged 4 months, although his age might well appear as 5 months in the hospital record.

The sex ratio at different ages is given in the final column of Table 3. Below the age of 9 months, males are only slightly in excess of females (55.4%); after 9 months the excess is very marked (77.7%). The difference in sex ratio between these two periods is significant (22.3 ± 5.6). For the ileo-colic variety alone this trend is also present (difference 23.6 ± 6.9). Numbers of cases of the ileo-ileal type are small, but it appears to differ from the ileo-colic variety in two respects: (a) age of patient is higher (77% over 9 months as compared with 39% in the ileo-colic series); and (b) sex ratio is higher (77.4% male as compared with 60.3%). The difference in sex ratio can be

attributed at least in part to the fact that ileo-ileal intussusceptions occur predominantly in the age period when intussusceptions of all types show a high sex ratio. Whether ileo-ileal cases also show a real increase in sex ratio independently of this age effect, as suggested in Table 3, cannot be determined on the numbers of cases available.

SEASONAL INCIDENCE

Previous reports on seasonal incidence of intussusception are conflicting. Bolling (1923) suggested that the condition was most common in the summer months; Close (1931) confirmed this finding for younger children, but found that after 1 year of age the condition was most common in the months December–March. High incidence in March and December was suggested by Fitzwilliams (1908) and in April and January by Perrin and Lindsay (1921). Hogg and Donovan (1946) and Hipsley (1935) found little or no seasonal variation. The present material is in agreement with the last observations. Table 4 shows no evidence of seasonal variation.

BIRTH WEIGHT

It has been frequently stated, without numerical evidence, that intussusception affects particularly children who are heavier or more well nourished than average. Weight at the time of illness is not available in the present series, but birth weight is known for 259 patients. Comparison of their birth weight with that of all births in

TABLE 4.—DISTRIBUTION OF AFFECTED ACCORDING TO MONTH OF OPERATION

Month of Operation	Patients Aged 0-8 Months			Patients Aged 9 Months and Over			Total		Total*
	Male	Female	Total	Male	Female	Total	Male	Female	
Jan-March	20	17	37	23	6	29	43	23	66
April-June	26	14	40	33	9	42	59	23	82
July-Sept	26	21	47	19	10	29	45	31	76
Oct-Dec	20	22	42	26	4	30	46	26	72
Total	92	74	166	101	29	130	193	103	296

* $\chi^2 = 1.8$, $n = 3$, $0.5 < p < 0.7$.

TABLE 5.—PERCENTAGE DISTRIBUTIONS ACCORDING TO BIRTH WEIGHT

Birth Weight (lb)	Affected		Birmingham Births, 1947	
	Male	Female	Male	Female
5 or less	3.0	8.6	8.8	11.2
6	25.3	31.2	20.5	25.9
7	34.3	40.9	34.9	36.2
8	26.5	16.1	24.5	20.0
9 or more	10.8	3.2	11.3	6.7
Total	99.9	100.0	100.0	100.0
No. of observations	166	93	11,602	10,811

Birmingham in 1947 (Table 5) suggests that at birth children with intussusception are of average weight. Hogg and Donovan (1946) noted that most patients fell within the normal weight limit for age and height.

BIRTH RANK AND MATERNAL AGE

The possibility of association between incidence and either birth order or maternal age has not previously been examined. Wakeley and Atkinson (1938) reported that 64 per cent of 121, and Hogg and Donovan (1946) 45 per cent of 123, patients were first born. Ravitch and McCune (1950) on the other hand considered that a surprising number of patients occupied the higher birth ranks.

In the present material both birth rank and maternal age were known for the 212 interviewed patients and for the 30 additional patients whose birth certificates were found. Birth rank alone was available from the original hospital record for an additional 33 patients. The sample of all births in Birmingham originally assembled by Record and McKeown (1949) was completed in respect of the years 1942-52 by Smith and Record (1955). The sample as now used was modified from the latter by (a) inclusion of additional years (1953-54) and (b) exclusion of years 1942-44 and of all stillbirths. It is in effect a $\frac{1}{200}$ th sample of all livebirths during the period 1945-54.

Distributions of the intussusception series and comparison sample are compared with respect to birth rank in Table 6 and to maternal age in Table 7. There are no significant differences. The independent effects of the two variables are examined in Table 8. To arrive at the estimates of incidence in different birth ranks and maternal ages it was assumed that (a) all livebirths in the city are distributed in the

TABLE 6.—DISTRIBUTION ACCORDING TO BIRTH RANK

Birth Rank	Affected Number	Affected Per cent	Comparison Number	Group Per cent	Difference Between Percentages
1	106	38.55	335	32.81	+5.74 ± 3.22
2	83	30.18	343	33.59	-3.41 ± 3.19
3	43	15.64	154	15.08	+0.56 ± 2.44
4	17	6.18	91	8.91	-2.73 ± 1.88
5 and over	26	9.45	98	9.60	-0.15 ± 2.00
Total	275	100.0	1021	100.0	—

TABLE 7.—DISTRIBUTION ACCORDING TO MATERNAL AGE

Maternal Age (years)	Affected Number	Affected Per cent	Comparison Number	Group Per cent	Differences Between Percentages
Under 20	8	3.31	53	5.19	-1.88 ± 1.53
20-24	56	23.14	247	24.19	-1.05 ± 3.05
25-29	81	33.47	319	31.24	+2.23 ± 3.33
30-34	54	22.31	233	22.82	-0.51 ± 3.00
35-39	33	13.64	131	12.83	+0.81 ± 2.40
40 and over	10	4.13	38	3.72	+0.41 ± 1.34
Total	242	100.0	1021	100.0	—

TABLE 8.—INCIDENCE OF INTUSSUSCEPTION (PER 1000 LIVEBIRTHS) ACCORDING TO BIRTH RANK AND MATERNAL AGE

Birth Rank	Maternal Age (years)						Total
	Under 20	20-24	25-29	30-34	35-39	40 and over	
1	1.12	1.82	1.90	1.45	2.25		1.72
2	0.88		1.39	2.12	0.59		1.32
3	0.82		2.01	1.09	2.17		1.55
4	—	0.87		0.61	1.62		1.04
5 and over	—	—	1.05	1.22	1.61	2.52	1.60
Total	0.95	1.43	1.60	1.45	1.59	1.66	1.49

same way as the comparison sample, and (b) untraced patients with intussusception are distributed in the same way as those traced. There is no consistent trend with birth order. Incidence may increase slightly with increasing maternal age, but the association is not constant and the results are no more than suggestive.

Results were also negative when the association of incidence with age and parity was examined separately (a) for ileo-caecal and ileo-ileal intussusceptions and (b) for patients under and over 9 months of age.

INCIDENCE IN SIBS

There were four fraternities in which two members were propositi in the present series, and a further four in which a sib born before the first propositus was affected. Some details of these eight fraternities are given in the appendix. Close (1931) found 5 instances of affected sibs in 146 reports, and Hogg and Donovan (1946) reported 3 cases among relatives of 123 patients.

For an estimate of the risk to sibs of an affected individual, attention is confined to the 209 families (containing 212 propositi) traced by field enquiry. These families include 3 with 2 propositi and 3 with an affected previous sib. An estimate of the risk to sibs can be obtained in two ways:

(a) By ignoring previous sibs and confining attention to sibs born after the first propositus. There were 128 such sibs, of which 3 (1 in 43) were affected.

(b) By using data for all family members and making the corrections described by Hogben (1931) for family size and the fact that fraternities are selected by the presence of at least one affected member. This procedure is followed in Table 9, the estimate of risk to siblings obtained in this way being 0.029 or approximately 1 in 34.

The results of both methods suggest that the risk to sibs is about 1 in 40, or between 15 and 20 times the incidence in the general population.

Numbers are very small, but examination of the appendix does not suggest that recurrence in a fraternity is associated with age or sex. With one exception, all the familial cases are ileo-caecal or ileo-colic in type, but this type accounts for 84 per cent of all cases.

Other affected relatives reported by the 209 interviewed mothers were maternal cousin (3), paternal cousin (3), mother's cousin (3), paternal uncle (2) and maternal

TABLE 9.—RISK OF INTUSSUSCEPTION IN SIBS OF PROPOSITI

Family Size	Number of Families	Number of Children	Number of Affected Observed	Children Expected* r = 0.029
1	40	40	40	40.00
2	69	138	70	69.97
3	38	114	40	39.12
4	28	112	29	29.23
5	11	55	13	11.66
6	12	72	12	12.90
7	7	49	7	7.63
8	2	16	2	2.21
9	1	9	1	1.12
10	1	10	1	1.14
Total	209	615	215	214.98

* Calculated from the formula $p = \frac{r}{1 - (1 - r)^s}$, where p = proportion affected, r = risk to siblings and s is family size.

uncle (1). No parents were affected. Hipsley (1935) states that he has seen a family in which father and child both had intussusception in infancy. The number of other relatives "at risk" is unknown, but in a previous enquiry into the familial incidence of pyloric stenosis in the same area (McKeown, MacMahon and Record, 1951) it was found that there were on average about 8 cousins to each propositus. On this basis about 2 affected cousins would have been expected in the present material. There were 6, but numbers are too small to justify the conclusion that incidence in cousins is raised.

SUMMARY

Survey of the records of all pediatric and general hospitals in the City of Birmingham, England, for the years 1945-54 revealed 296 confirmed cases of intussusception in Birmingham children under the age of ten years. In addition to data in the hospital record, information was obtained for 212 cases by interview with the mother during 1955, and from birth certificates of a further 30 patients who could not be traced in 1955.

The incidence of the condition was 1.49 per thousand livebirths. 65.2% of the patients were less than 1 year of age, the modal age being 4 months. Below the age of nine months males were only slightly in excess of females (55.4%); after nine months the excess was very marked (77.7%). Differences in age and sex distribution between the ileo-ileal and ileo-colic types were noted.

No significant evidence of the influence of season, birth weight, birth rank or maternal age was found.

There were eight fraternities in which two members were affected. The risk to sibs of an affected individual is estimated as about 1 in 40, or between 15 and 20 times the incidence in the general population.

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APPENDIX.—DETAILS OF 8 FAMILIES IN WHICH 2 CHILDREN HAD INTUSSUSCEPTION

No. of Family	Date of Mother's Birth	Birth Rank of Child	Date of Birth	Sex	Age at Operation	Type of Intussusception
1	6/8/17	1*	11/7/44	M	6 mos.	Ileo-colic
		2*	20/1/50	M	12 mos.	Ileo-caecal
2	23/6/20	1	1/8/41	F		
		2	6/8/43	M		
		3*	2/2/45	F	8 mos.	Ileo-colic
		4	2/2/49	M		
		5*	8/7/52	M	3 mos.	Caeco-colic
3	12/2/24	1*	30/5/46	M	3 mos.	Not stated
		2	11/8/48	F		
		3*	16/1/50	M	3 mos.	Ileo-colic
4	25/12/22	1†	18/2/43	M	5 mos.	Ileo-colic
		2	23/11/47	M		
		3*	20/12/52	M	4 mos.	Ileo-colic
5	7/3/13	1	12/4/35	M		
		2†	29/7/42	F	5 mos.	Not stated
		3*	30/12/44	M	1 yr 11 mos.	Ileo-caecal
		4	15/9/45	F		
6	5/10/06	1†	2/8/31	F	5 mos.	Not stated
		2	29/3/36	M		
		3	18/7/37	F		
		4	30/4/47	M		
		5*	6/2/50	F	3 mos.	Ileo-caecal
7	?	1*	7/3/48	M	3 mos.	Ileo-colic
		2	? ? 50	F		
		3*	1/9/52	F	10 mos.	Ileo-caecal
8	?	1†	?	?	4 mos.	?
		2*	1/3/46	F	4 mos.	Ileo-caecal

* Indicates a propositus, and † an affected child, not a propositus. Families 7 and 8 were not traced by field enquiry, and are omitted for the purposes of estimating incidence in sibs (see text)