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Incidence, clinical presentation and management: a global perspective

World Health Organization
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Incidence, clinical presentation and management: a global perspective

A report prepared for the Steering Committee on Diarrhoeal Disease Vaccines, Vaccine Development, Vaccines and Biologicals, World Health Organization, Geneva, Switzerland

Julie E. Bines, M.D., F.R.A.C.P., Paediatric Gastroenterologist,
Royal Children's Hospital, University of Melbourne, Melbourne, Australia
Bernard Ivanoff, PharmD., Ph.D., Vaccine Development,
Vaccines and Biologicals, World Health Organization, Geneva, Switzerland

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World Health Organization
Department of Vaccines and Biologicals
CH-1211 Geneva 27, Switzerland
• *Fax:* + 41 22 791 4227 • *Email:* vaccines@who.int •

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Chapter 1:
Introduction

Rotavirus is the most common cause of severe, dehydrating gastroenteritis among children globally, resulting in approximately 600 000 to 850 000 deaths each year (de Zoysa & Feachem, 1985; Institute of Medicine, 1986). Most deaths occur in developing countries, where access to rehydration therapy and other medical care is often limited and where the disease burden is unlikely to be significantly reduced by improvements in hygiene and sanitation. Over the past two decades there has been a major effort to develop a safe and effective rotavirus vaccine to prevent the significant morbidity and mortality associated with rotavirus infection, particularly in developing countries.

The first rotavirus vaccine to be approved was licensed in the USA in August 1998 and was subsequently recommended for all infants in the country as part of their routine immunization schedule (RRV-TV, tetravalent rhesus-human ressortant rotavirus vaccine, RotashieldÒ, Wyeth Lederle Vaccines, Philadelphia). In July 1999 the United States Centers for Disease Control and Prevention (CDC) reported 15 cases of intussusception in infants who had received RRV-TV vaccination (Centers for Disease Control and Prevention, 1999a). Episodes of intussusception peaked between day 3 and day 14 after the first dose of RRV-TV (adjusted odds ratio, 21.7), with an attributable risk estimated at 1 in 4670 to 9474 infants vaccinated (Murphy et al., 2001). In response to the suspected association between intussusception and receipt of the vaccine, CDC and the American Academy of Pediatrics suspended its recommendation for routine use of RRV-TV in July 1999 (Centers for Disease Control and Prevention, 1999a). In October 1999 the Advisory Committee on Immunization Practices withdrew its recommendation for use of RRV-TV in the USA and the vaccine was voluntarily withdrawn by the manufacturer (Centers for Disease Control and Prevention, 1999b). It is estimated that, during the nine-months when RRV-TV was availabe in the USA, 1.5 million doses were administered to approximately 1 million infants (Simonsen et al., 2001). Follow-up studies of this birth cohort have not revealed any evidence of increased intussusception rates in infants during the 1998–1999 period of RRV-TV availability in 10 states of the USA (Chang et al., 2001; Simonsen et al., 2001). This has raised questions about the etiology of intussusception and about the suggestion that the vaccine may have acted as a trigger for the development of intussusception in some infants.

The recommendation to withdraw the only rotavirus vaccine to be licensed in the USA has made it necessary to reassess the priority activities in rotavirus vaccine development, particularly for developing countries. In February 2000, therefore, WHO organized a meeting with the aim of redefining the future directions for rotavirus vaccine research in these countries. A major recommendation of this meeting was that the global incidence and clinical presentation of intussusception among children in developing countries should be reviewed (WHO/V&B/00.23).

Intussusception is the most common cause of acute intestinal obstruction in infants and young children. It occurs when one segment of bowel invaginates into the distal bowel, resulting in venous congestion and bowel wall oedema. If intussusception is not diagnosed and treated promptly the arterial blood supply to the bowel may be obstructed, causing bowel infarction and perforation. Untreated intussusception is a potentially lethal condition.

The present report responds to the recommendations of the above-mentioned meeting. Based on an extensive review of published literature from 70 developing and developed countries, it aims to define the baseline incidence of acute intussusception in infants and children, the clinical presentation of the condition, and current trends in its management in these countries.

Chapter 2:
Literature search and review methodology

2.1 Search strategy

2.1.1 Electronic bibliographic database search

An extensive literature review was conducted by means of the following electronic bibliographic databases.

- Medline (1966 to February 2001). This database is provided by the United States National Library of Medicine and is widely recognized as the premier source of bibliographic and biomedical literature. It contains more than 9.5 million records from more than 3900 journals
- Popline (1983 to 2000) and pre-1983. This database originates from the Johns Hopkins University Population Information Program. It contains over 200 000 citations with detailed abstracts and indexing and covers all types of publications, including journals, monographs and technical reports. About 30% of the documents are unpublished reports that are difficult to obtain. The focus is on population studies. Articles on maternal and child health are included.
- Cochrane Library Online (1999 to 2000). This source provides reference material from the Cochrane Collaboration, an international organization that helps people to make informed decisions about health care by preparing, maintaining and promoting the accessibility of systematic reviews of the effects of health care interventions.

The literature search was conducted in two phases.

Phase 1

This was based on the keywords “intussusception” and/or “intestinal invagination”. Medline yielded 3254 references published between 1966 and February 2001. Each complete reference and/or abstract was reviewed for all references. The search was then limited to studies on (i) humans, and (ii) persons aged 0–18 years. The latter restriction was imposed in order to reflect the epidemiology or clinical presentation of intussusception in the paediatric population. This strategy resulted in the identification of approximately 1628 references by means of Medline. Popline failed to identify any articles not already identified by Medline. No entries were found in Cochrane Library Online, and no meta-analysis was found which focused on the diagnosis or management of intussusception in the paediatric population.

Phase 2

The references identified in Phase 1 were individually reviewed. Publications describing any data on the epidemiology, clinical presentation and/or management of the disease were selected and summarized (Annex 1).

Papers primarily concerned with the following subjects were excluded:

- adults;
- chronic and recurrent intussusception;
- intussusception as a secondary manifestation of another disease such as tumour, vascular or congenital malformations, and Meckel's diverticulum;
- case reports;
- surgical or radiological treatment.

2.1.2 Reviews of references sourced from additional papers

Additional papers were sourced from publications referred to in the articles selected for initial review on the basis of the above methodology.

2.1.3 References to WHO reports

The *Report of the meeting on future directions for rotavirus vaccine research in developing countries, Geneva, 9–11 February 2000* (WHO/V&B/00.23) was used to provide additional data on the baseline incidence of intussusception in developing countries.

2.2 Review methodology

References were initially classified into the continent and country of origin. A data retrieval sheet was developed in order that the greatest possible amount of information could be extracted in a reliable and standardized format (Annex 1). The data from individual reports were compiled in tables according to the countries of origin. The references in the publications found in Phase 1 were reviewed in order to identify publications not found in the computer database search.

2.3 Data presentation

Chapter 3 documents the reference base for data presented in this report. Chapters 4 and 5 define the incidence and clinical pattern of intussusception in developing and developed countries. The data in these chapters are presented by geographical region. Data from the individual studies have been extracted and compiled in tables according to the country of origin. These tables present a global summary of the published data on intussusception with reference to specific topics relevant to the clinical epidemiology of the condition. Chapters 4 and 5 summarize and interpret the data compiled from the individual reports in order to establish a regional picture of the incidence, presentation and management of intussusception. Studies are highlighted which give additional insights into the epidemiology of intussusception in particular regions.

Chapter 3:
Reference base

The search strategy outlined in Chapter 2 resulted in the identification of 330 publications for review, 269 of which were selected and summarized. The selected studies represent the clinical pattern of intussusception in infants and children in 70 countries (Table 1). The geographical pattern for the papers selected for inclusion in this report is indicated in Tables 1 and 2.

Africa

Fifty-two publications from Africa were identified by means of the search strategy outlined in Chapter 2. Forty-five of them, containing data with a bearing on the incidence and clinical manifestations of acute intussusception in childhood, were selected for summary. Twenty-two reports originated in Nigeria and the remaining 23 came from 16 other countries.

Asia

Fifty-eight publications were identified. Forty-eight, containing epidemiological and clinical data from 12 countries, were selected and summarized (Tables 1 and 2). Eighteen of the 48 selected reports originated in India.

Eastern Mediterranean

Twelve publications from the Eastern Mediterranean were identified. Eleven references were identified by means of Medline and one was obtained from a bibliography. Eight publications describing data from five countries were selected for summary.

Central and South America

Ten publications were identified by means of the search strategy outlined in Chapter 2. Seven references were sourced from Medline and three from the above-mentioned report (WHO/V&B/00.23). All of these references were selected for inclusion.

North America

Forty-six reports from Canada and the USA were identified by means of Medline or in bibliographies. Data from 39 of these publications were selected and included in the report.

Europe

One hundred and thirty-seven studies on intussusception and intestinal invagination were published in the following regions.

Western Europe	54
Eastern Europe	38
Central Europe	15
Northern Europe	15
Southern Europe	15

Data from 108 of these studies were selected for inclusion in the report.

Oceania

Fifteen publications were identified, of which eleven were selected for inclusion. No references in the available literature reported the incidence of intussusception in Papua New Guinea or the Pacific Island countries.

Table 1: References identified and selected according to regions

Region	Number of references		Number of countries represented
	identified	selected	
Africa	52	45	17
Asia	58	48	12
Eastern Mediterranean	12	8	5
Oceania	15	11	3
Central and South America	10	10	7
North America	46	39	2
Europe	137	108	24
Total	**330**	**269**	**70**

Table 2: References identified and selected according to countries of origin

Country	Number identified	Reviewed	Selected
Africa			
Burkina Faso	1	1	1
Egypt	4	4	2
Ethiopia	4	4	4
Ghana	1	1	1
Kenya	1	1	-
Libya	1	1	-
Niger	1	1	1
Nigeria	22	22	22
Rwanda	2	2	1
South Africa	5	5	4
Tunisi	2	2	2
Senegal	1	1	1
Sudan	2	2	2
Uganda	1	1	1
Zaire	1	1	1
Zambia	2	2	1
Zimbabwe	1	1	1
Subtotal	**52**	**52**	**45**
Asia			
Bangladesh	1	1	1
China	5	5	5
Hong Kong, China	1	1	1
India	18	18	17
Indonesia	3	3	2
Japan	10	10	4
Republic of Korea	4	4	4
Malaysia	2	2	2
Myanmar	1	1	1
Taiwan, China	11	11	9
Thailand	1	1	1
Viet Nam	1	1	1
Subtotal	**58**	**58**	**48**
Eastern Mediterranean			
Iran	5	5	4
Kuwait\	1	1	1
Lebanon	4	4	1
Qatar	1	1	1
Saudi Arabia	1	1	1
Subtotal	**12**	**12**	**18**
Oceania			
Australia	12	12	10
New Zealand	1	1	1
Papua New Guinea	2	2	-
Subtotal	**15**	**15**	**11**

Table 2: *(continued)*

Country	Number identified	Reviewed	Selected
Central and South America			
Brazil	1	1	1
Chile	2	2	2
Haiti	1	1	1
Peru	1	1	1
Puerto Rico	1	1	1
Trinidad and Tobago	2	2	2
Venezuela	2	2	2
Subtotal	**10**	**10**	**10**
North America			
Canada	12	12	12
USA	34	34	27
Subtotal	**46**	**46**	**39**
Europe			
Belgium	2	2	1
Bulgaria	2	2	1
Czech Republic	2	2	2
Denmark	3	3	3
Finland	2	2	2
France	12	12	11
Germany	9	9	6
Hungary	4	4	3
Israel	1	1	1
Italy	6	6	5
Netherlands	9	9	5
Norway	4	4	3
Poland	1	1	1
Portugal	1	1	1
Russian Federation/ Ukraine/former USSR	34	34	24
Spain	6	6	6
Sweden	6	6	6
Switzerland	1	1	1
Yugoslavia	2	2	1
United Kingdom and Ireland	30	30	25
Subtotal	***137***	***137***	***108***
Total	**330**	**330**	**269**

Chapter 4:
Global incidence of acute intussusception

Accurate estimates of the incidence of intussusception are not available for most developing countries and many developed countries (Table 3). Most studies reporting the incidence of intussusception are hospital-based. In general they are retrospective chart reviews of patients with intussusception presenting to a single hospital over a specific period or they represent the experience of a surgeon or a group of surgeons. Some studies have reported the annual incidence rate of intussusception with respect to non-intussusception hospital admission data or to the demographics of the communities concerned. Retrospective hospital-based studies may underestimate the incidence of intussusception as they do not take account of patients who may present to other hospitals or clinics within the region in question or who may die elsewhere than in hospital or while being treated for an alternative diagnosis. Because of limited radiological facilities in some regions the diagnosis of intussusception may not be established in some patients. While patients with intussusception may progress to bowel obstruction and death if the intussusception is not reduced, a small proportion of patients may have a spontaneous reduction of intussusception before the diagnosis is confirmed by radiological or surgical techniques (Swischuk et al., 1994). Conversely, the incidence of intussusception may be overestimated in some hospital-based studies because varying levels of evidence are required to make a diagnosis. In some regions, for example, patients with a history and examination findings suggestive of intussusception may be treated with an air or hydrostatic enema without formal documentation of intussusception by radiology or surgery. If the symptoms resolve following treatment with an enema it is presumed that the patients had intussusception.

The aim of this chapter is to describe the published data and to highlight differences between studies and between regions. In order to address the methodological problems outlined above satisfactorily it is necessary to conduct prospective population-based studies on intussusception.

Africa

As there are no published studies reporting the incidence of intussusception relative to the population of infants and children, an accurate estimation of the incidence of acute intussusception in children in Africa is not possible at present. Furthermore, there is no national coordinated study that could assist in estimating the incidence of acute intussusception in any country. The majority of studies on intussusception are retrospective chart reviews of admissions for acute intussusception over a specific period at a single hospital. One study was a retrospective chart review of acute intestinal obstruction in three hospitals within a region (Archibong et al., 1994). There are five prospective studies describing the presentation and management of acute intussusception in children attending a single hospital (Soukati et al., 1996;

Otu, 1991; Harouna et al., 1997; Hadidi et al., 1999; Meier et al., 1996). One of these studies made a comparison of clinical presentation, management and outcome between 50 consecutive patients with intussusception who attended a hospital in Nigeria and patients who attended two hospitals in the USA (Meier et al., 1996). Eight other studies reported the number of cases of acute intussusception with reference to either the number of hospital or surgical admissions per year or the number of patients presenting with intestinal obstruction (Table 4). Because of the lack of specific information on intussusception in children in Africa, the numbers of patients with acute intussusception reported in the studies from Africa have been compiled in Table 4. Analysis of these figures within various regions of Africa may assist in assessing the scope of the problem of intussusception, even if accurate rates of occurrence cannot be determined on the basis of the data currently available.

In the absence of a more precise estimate of the baseline incidence of acute intussusception in Africa, the data from the studies in Nigeria were complied in an attempt to estimate the annual incidence of acute intussusception in childhood. During the period 1974–1995, hospitals in nine regions of this country published reports in which the annual number of cases of acute intussusception were recorded. The annual number of live births during this period ranged from approximately 2500 in 1974 to 4395 in 1994 (United States Census Bureau, International Database 2000). The annual number of new cases was estimated to be 71.9 on the basis of these figures.

The annual incidence of acute intussusception also appears to vary from year to year in hospitals in different parts of Africa. In South Africa, a twofold increase from 15 cases in 1964 to 30 cases in 1968 was observed (Mayell, 1972). In Port Harcourt, Nigeria, two cases per year were reported in 1985; a steady increase occurred to a peak of 15 cases in 1989, and this was followed by a decline to three cases in 1992 (Mangete, 1994). In Addis Ababa, Ethiopia, the incidence ranged between four and ten cases per year during the period 1977-1986 (Gudeta, 1993). It has been suggested that epidemics and environmental factors influencing dietary intake or food contamination may underly these marked differences.

Over the past 20 years there has been a decline in the incidence of adult intussusception in some regions of Nigeria, where the majority of adult episodes were reported in the caeco-caecal, caeco-colic or colo-colic region, and from 1975 to 1994 there was a 30.6% decline in the absolute number of infants and children presenting with acute intussusception, despite stable hospital admission rates and policies (Adebamowo et al., 2000). It has been suggested that increasing Westernization of the local diet containing high-fibre roots rich in nitrosamines has contributed to the changed incidence of intussusception by affecting gut motility. Although parasites have been associated with caecal intussusception, the incidence of *Ascaris* in patients with intussusception is reported to be similar to that in the general population (VanderKolk et al., 1996).

In Ghana, more than a threefold increase in the annual incidence of acute intussusception was reported between the 1960s (approximately 6.2/year) and 1988 (20.5/year) (Archampong et al., 2000). It is not clear whether this reflects a true increase in the annual incidence or improved facilities for diagnosis and treatment.

Asia

The incidence of intussusception was determined in only one study from Asia on the basis of retrospective data from five hospitals in Taiwan, China, during the period 1955-1964 (Clarke, 1969). In this study the incidence rate was reported as 0.77 per 1000 live births. During this period, 42.4 cases per year of acute intussusception in children were treated in the hospitals; 82% of the patients presented when under 1 year of age. However, a more recent publication from Taipei reported 21.3 new cases per year and indicated that only 37.5% of the patients were under 1 year old (Hsu et al., 1998). This discrepancy in the numbers and the ages of patients with intussusception may be partly explained by the different study designs. However, a change in the epidemiology of intussusception in Taiwan over this 30-year period cannot be excluded.

In India there appears to be some regional variability in hospital-based studies: the number of cases of intussusception ranges from 1.9 to 54.4 per year (Table 4). None of the studies reported the incidence of intussusception relative to the number of live births, although three studies reported the annual incidence of intussusception relative to either the number of hospital admissions (0.5% and 0.7% for New Dehli in 1961–1967 and 1993–1997 respectively) or the number of surgical admissions (1.7% for New Dehli in 1961–1967) (Taneja, 1970; WHO/V&B/00.23, 2000).

In China the incidence of intussusception in hospital-based studies is reported to be increasing. In 1986, Guo and co-workers presented the results of air-pressure enema reduction of intussusception in 6396 cases over a 13-year period at the Shanghai Children's Hospital. Variability between the numbers of patients presenting each year ranged from 279 cases in 1974 to 829 cases in 1983 (Guo et al., 1986). There was an increasing trend in the numbers treated in the later years of the study. On one occasion, 12 cases of intussusception were treated at the hospital in a single night. However, there has been some discussion on the substantiation of the diagnosis of intussusception in this study before reduction was performed (Guo et al., 1986). Unfortunately, no demographic data were available and consequently the incidence of intussusception could not be estimated.

In Viet Nam, in the period 1995–1999 between 472 and 722 cases of intussusception were reported annually in children under 12 months of age who presented to hospitals in Hanoi, Hue and Ho Chi Minh City. This represented 5-8% of all hospital admissions (WHO/V&B/00.23, 2000). In Malaysia, approximately 10.4 infants and children per year were treated for intussusception at the 2000-bed Kuala Lumpur General Hospital (Laidin et al., 1982).

Concurrent studies in Indonesia in an urban specialist children's hospital and a rural community hospital revealed a higher number of patients presenting each year to the urban hospital (17.2 and 5.8 respectively) (van Heek et al., 1999). However, the urban figure represented a lower proportion of total hospital admissions than occurred in the rural hospital (0.6% and 1.2% respectively).

In a report from the Republic of Korea in 1965, it was suggested that intussusception had a distinctive clinical presentation in this country (Dietrick et al., 1965). Intussusception was reported to be primarily a disease of adults: only 11.7% of patients with intussusception were aged under 2 years. The incidence of intussusception in adults in the Republic of Korea was estimated to be 1 in 1600 new patients, more than 17 times that reported in the USA. However, two further hospital-based studies in 1968 and 1989 contradicted this finding and reported that intussusception occurred mainly in children under 1 year of age with a presentation and clinical course similar to those described in other studies (Suh et al., 1968, Kim et al., 1989). Nonetheless, the incidence of intussusception is high in the Republic of Korea on average, 64 patients present annually to a single hospital (Table 4).

The number of cases of acute intussusception in hospital-based studies varied from year to year in studies conducted in Asia. In Taiwan, China, the incidence decreased from 1.23/1000 live births in 1958 to 0.363/1000 live births in 1960 (Clarke, 1969), whereas in Kerala, India, an increase in the number of patients presenting with intussusception was observed between 1981 and 1985 (45 and 64 cases respectively) (Gopi, 1989). No explanation has been found for such variation.

Eastern Mediterranean

The incidence of intussusception was comparatively low in Kuwait (0.5/1000 live births) (Issa et al., 1988), and in Saudi Arabia less than one case of intussusception was diagnosed per year among patients of all ages (Mohamed et al., 1997). Most other centres in the Eastern Mediterranean reported an average of 10 cases per year on the basis of hospital admissions but provided no demographic data that would permit incidence to be estimated (Table 4).

Central and South America

The annual incidence of intussusception reported in South America was lower than that reported in other continents. In Venezuela an annual incidence of 24 infants with intussusception per 100 000 children aged under 1 year has been reported (WHO/V&B/00.23, 2000). A higher proportion of affected infants (62%) belonged to families in the middle or lower-middle economic category. In Brazil the National Hospital Coding System indicated the annual incidence of intussusception to be 3.5 cases/100 000 infants aged under 1 year (WHO/V&B/00.23, 2000). This large difference in the incidence of intussusception between Brazil and Venezuela may, at least in part, relate to differences in the methods of data collection. In Venezuela the incidence data were based on the number of patients presenting to a single hospital relative to the population of children under 1 year of age (WHO/V&B/00.23, 2000). The data from Brazil were calculated from national incidence data documenting the ICD (International Classification of Diseases) codes for intussusception in children under 1 year old (WHO/V&B/00.23, 2000). However, regional differences in reporting may have contributed to an underestimation of the incidence of intussusception in Brazil (WHO/V&B/00.23, 2000). In Trinidad and Tobago a sixfold increase in the annual incidence of intussusception was reported between 1974 and 1983 (Kuruvilla et al., 1988); the explanation for this increase remains unclear.

North America

The incidence of intussusception was estimated to be between 0.5 and 2.3 cases per 1000 live births in the USA (Bruce et al., 1987; Rennels et al., 1998) (Table 4). In a recently published prospective study on the association between oral rotavirus vaccine and intussusception, data from infants with intussusception were analysed from 19 states of the USA (Murphy et al., 2001). During the eight-month study period, 446 cases of intussusception were diagnosed in infants aged between 1 and 12 months. This equates to an annual incidence of 669 cases in the 19 states included in the study.

Most major paediatric centres in the USA reported between 2 and 26 new cases of acute intussusception in infants and children each year (Table 4). In Toronto, Canada, an average of between 34 and 45 new cases were diagnosed each year between 1958 and 1996 (Table 4). Hospitalizations for acute intussusception in the USA were analysed on the basis of data from the Indian Health Service (1980–1997), the National Hospital Discharge Survey (1988–1997), California (1990–1997), Indiana (1994–1998) and MarketScan (1993–1996) (Parasher et al., 2000). During 1994–1996 the annual rate of intussusception-associated hospitalization varied among the data sets from 18 per 100 000 (Indian Health Service) to 56 per 100 000 (National Hospital Discharge Survey). A decline in the incidence of intussusception was observed in infants attending the Indian Health Service between 1980–1982 and 1995–1997.

Europe

The incidence of acute intussusception in infants, as estimated from hospital-based studies, is between 1.1 and 4.3 per 1000 live births or 0.66 to 1.2 per 1000 infants aged under 1 year (Table 3). In England the nationwide incidence of intussusception was estimated from data on admissions to the National Health Service between April 1993 and March 1995 (Gay et al., 1999). On the basis of mid-year age-specific population estimates the rate of intussusception in England was calculated to be 0.66 cases per 1000 population. In Aberdeen, Scotland, a decline in the incidence of intussusception was reported between the 1950s and the mid-1970s, particularly in females, in infants under 1 year of age, and in rural areas (Pollet et al., 1980). No similar decline was reported in Newcastle or other neighbouring regions (Tables 3 and 4). However, a small difference in incidence was noted between city and rural areas in Norway and Scotland (Table 3) (Eikeset et al., 1998; Steyn et al., 1961). A hospital-based study in Israel indicated the incidence of intussusception to be 2.4/1000 live births (Eshel et al., 1997). There was a twofold difference between Jews and Arabs presenting to the same hospital (2.36/1000 live births and 0.96/1000 live births respectively).

The annual incidence of intussusception in infants presenting to hospitals throughout Europe varied from 1.5 to 73 cases (Table 4). The available data do not make it possible to determine whether these differences reflect any regional differences in incidence, demographic differences, patient referral patterns and/or hospital activity. The highest annual incidence of intussusception was reported in Spain, where 73 cases per year in Madrid and 64 cases per year in Vizcaya were reported (Barrio Gomez de Aguere et al., 1987; Lesarte et al., 1990). Centres in the Russian Federation reported over 25 cases per year (Antoshkina et al., 1990; Shchitinin et al., 1989; Sitkovskii et al., 1981, 1997; Chepurnoi et al., 1996; Khristich et al., 1977; Kushch et al., 1978; Novokreshchenov et al., 1987).

Oceania

The incidence of acute intussusception in infants in Australia and New Zealand is estimated at 0.64 per 1000 live births or 0.5 per 1000 children aged 0-14 years on the basis of hospital studies (Table 3). These rates are comparable to those observed in the USA and are slightly lower than those for the United Kingdom (Table 3). No published incidence data were available for Papua New Guinea or the Pacific Islands. Due to the centralized nature of specialized paediatric services in Australia and New Zealand, most major paediatric hospitals treated between 26 and 38 new cases of intussusception per year (Table 4). There were no data suggesting any significant change in the incidence of intussusception in Australia or New Zealand.

Table 3: Mean annual incidence of intussusception in infants and children

Country	Date of data	Mean annual incidence (per 1000 live births)	Mean annual incidence (per 1000 children under 1 year of age)	Author	Year of publication
Asia					
Taiwan, China:					
Taipei	1955–64	0.77		Clarke	1969
Eastern Mediterranean					
Kuwait:	1977–86	0.50		Issa	1988
South and Central America					
Venezuela:					
Carabobo	2000		0.24	WHO/V&B/00.23	2000
Brazil:					
National statistics	1997–98		0.035	WHO/V&B/00.23	2000
North America					
USA:					
Buffalo	1930–85	2.30		Bruce	1987
California	1995–96	0.74		Rennels	1998
New York	1991–95	0.50		Rennels	1998
Europe					
Israel:					
Zerifin	1985–95	2.24		Eshel	1997
Norway:					
Hordaland	1983–92	1.80 Bergen		Eikeset	1998
		1.40 County		Eikeset	1998
Netherlands:					
Nijmegen	1968–88	1.1		Reijnen 1990a	1990
Sweden:					
Malmo	1969–80	2.5	0.66	Carstensen	1984
Gothenberg	1936–66	2.2		Bjarnason	1968

Table 3: *(continued)*

Country	Date of data	Mean annual incidence (per 1000 live births)	Mean annual incidence (per 1000 children under 1 year of age)	Author	Year of publication
United Kingdom					
England	1993–95		1.2	Gay	1999
(National Health Service hospitals)					
Aberdeen	1950–59	1.8 City	0.72	Steyn	1961
	1950–59	2.20–2.70 rural		Steyn	1961
	1950–59	2.20 total region		Steyn	1961
Aberdeen	1967–76			Pollet	1980
Birmingham	1945–54	1.50		MacMahon	1955
Edinburgh	1950–58	1.60		Smith	1960
Sheffield	1950–59	2.30		Ross	1951
Newcastle	1944–49	3.80		Spence	1950
Newcastle	1950–57	4.30		Court	1959
Oceania					
Australia:					
Adelaide	1979–84		0.50 (per 1000 children 0–14 yrs)	Sparnon	1984
New Zealand:					
Auckland	1975–59	0.64		Raudkivi	1981

Table 4: Mean annual incidence of intussusception according to city, country and date of report

Country/ dates of data collection	Site	Mean annual incidence (patients/year)	Author	Publication year	Reference to hospital activity
Africa					
Burkina Faso					
1993–97	Yalgado-Ouedraogo	4.8	Bonkoungou	1999	4% all I.O.*
Egypt					
1973–76	Cairo	60	El-Barbari	1978	
1994–97	Cairo	42	Hadidi	1999	
Ethiopia					
1963–70	Addis Ababa	5	Wadleyes	1972	1.8% surg ad^
1977–86	Addis Ababa	7.2	Gudeta	1993	
1984–88	Addis Ababa	10	Daniel	1990	2.2% surg ad,^ 0.5% hosp ad#
1990–97	Gondar	1.9	Kedir	1998	
Ghana					
1965–69	Accra	6.2	Archampong	2000	
1975–79	Accra	6.2	Archampong	2000	
1987–88	Accra	20.5	Archampong	2000	
Nigeria					
1957–66	Ibadan	24	Solanke	1968	
1958–62	Ibadan	18.8	Elebute	1964	
1973–82	Calabar	4.4	Otu	1991	
1974–80	Benin City	3.4	Odita	1981	
1974–82	Benin City	3.9	Akamaguna	1985	
1975–78	Ibadan	2.1	Ajao	1980	
1975–84	Zaria	7.8	Momoh	1987	
1975–94	Ibadan	12.1	Adebamowo	2000	
1981–86	Kaduna	16.7	Udezue	1988	
1981–95	Zaria	6.1	Ameh	1996	
1981–90	Zaria	6.9	Nmadu	1992b	
1981–88	Ife-Ife	4.9	Adejuyigbe	1991	
1981–90	Zaria	6.0	Nmadu	1992a	
1981–90	Calabar	6.6	Archibong	1994	22.4% I.O.*
1985–92	Port Harcourt	10	Mangete	1993	
1985–92	Port Harcourt	10	Mangete	1994	
1982–88	Port Harcourt	1	Elechi	1990	
1985–94	Ilesa	2	Adesunkanmi	1996	14% I.O.*
1996	Ogbosmoso	13.5	Meier	1996	
1990–98	Jos	9.6	Ogwa	2000	
Niger					
1989–90	Niamey	6.6	Harouna	1997	
South Africa					
1961–70	Cape Town	23.5	Mayell	1962	
1968–75	Cape Town	24.6	Davies	1978	
1985*	Durban	12.7	Postma	1985	
1986*	Johannesburg	29	Isdale	1986	
Sudan					
1972–74	Khartoum	3.3	Hassan	1976	
1994–95	Khartoum	20	Sourkati	1996	

Table 4: *(continued)*

Country/ dates of data collection	Site	Mean annual incidence (patients/year)	Author	Publication year	Reference to hospital activity
Tunisia					
1981–89	Sfax	3.6	Mahfoudah	1993	0.18% hosp ad#
Uganda					
1972–76	Kampala	10	Sekabunga	1978	
Zaire					
1964–78	Kinshasa	1.7	Badibanga	1980	
Zambia					
1980–82	Lusaka	30	Munkonge	1983	
Zimbabwe					
1967–71	Harare	12.4	Chapman	1973	0.2% surg ad^
Asia					
Bangladesh					
2000	Dakha	70	WHO/V&B/00.23	2000	
Myanmar					
1984–86	Rangoon	20.5	Thein	1990	
China					
1974–86	Shanghai	492	Guo	1986	
1985–87	Beijing	142	Wang	1988	
1985–88	Shanghai	199	Gu	2000	
India					
1961–67	New Delhi	3.9	Taneja	1970	0.5% hosp ad# 1.7% surg ad^
1960–66	Pondicherry	1.9	Chatterjee	1972	
1961–66	Mangalore	2.2	Nadkarni	1972	
1967–72	Hyderabad	10	Madhusudhana	1975	
1968–71	Chandigarh	6.7	Pandit	1972	
1968–72	New Delhi	15	Talwar	1973	
1968–78	Chandigarh	6.1	Rao	1979	
1968 (3.5 yrs)	New Delhi	6.1	Taneja	1968	
1968–85	Chandigarh	9.8	Yadav	1986	
1966–90	Jaipur	9.2	Shekhawat	1992	
1970–77	Maharashtra	2.6	Belokar	1978	
1976 (5 yrs)	Haryana	8.4	Singh	1976	
1981–85	Kerala	54.4	Gopi	1989	
1996*	Manipal	2.2	Rao	1996	
1993–97	New Delhi	3.4	WHO/V&B/00.23	2000	0.7% hosp ad#
1990–2000	Haryana	7	Rattan	2000	
Indonesia					
1987–88	Medan	19.5	Lubis	1990	0.5% hosp ad#
1990–95	Jogyakarta	5.8	van Heek	1999	1.2% hosp ad#
1990–95	Jakarta	17.2	van Heek	1999	0.6% hosp ad#
Japan					
1965–68	Oita	9	Kato	1969	
1982–92	Gumna	1.7	Ikeda	1993	
1982–99	Hiroshima	6.1	Okuyama	1999	
Republic of Korea					
1961–63	Kwangju	1 (<2 yrs;8.5 all)	Dietrick	1965	
1964–68	Soeul	16	Suh	1968	0.2% hosp ad#
1982–87	Taegu	64	Kim	1989	

Table 4: *(continued)*

Country/ dates of data collection	Site	Mean annual incidence (patients/year)	Author	Publication year	Reference to hospital activity
Hong Kong, China					
1997	Hong Kong	11.7	Peh	1997	
Malaysia					
1968–72	Kuala Lumpur	2.8	Ti	1976	
1971–80	Kuala Lumpur	10.4	Laidin	1982	
Taiwan, China					
1955–64	Taipei	42.4 (all ages)	Clarke	1969	
1963–72	Kaohsiung	10	Lee MT	1973	0.03% treated°
1965–66	Taipei	28.5 (all ages)	Clarke	1969	
1978–87	Taipei	16.3 (<1yr; 22.8 all ages)	Pang	1989	
1980–85	Taipei	19	Lee CT	1988	
1982–92	Taoyuan	33	Chung	1994	
1994–97	Taipei	8 (<1yr; 21.3 all ages)	Hsu	1998	
Thailand					
1970–77	Bangkok	6.4	Sutthiwan	1982	
Viet Nam					
1995–99	Hanoi, Ho Chi Minh City	472–722	WHO/V&B/00.23 2000	5–8% hosp ad#	
Eastern Mediterranean					
Lebanon					
1962–69	Beirut	10	Bitar	1969	
Iran					
1970*	Shiraz	10	Farpour	1970	
Kuwait					
1977–86	Al-Aquol	23.3	Issa	1988	
Qatar					
1984–89	Doha	11.2	Dawod	1992	
Saudi Arabia					
1983–93	Jeddah	<1	Mohamed	1997	
Central and South America					
Brazil					
1997–98	National statistics	101	WHO/V&B/00.23	2000	
Chile					
1957–69		5	Fadda	1970	
1989–99	Santiago	7.2	Montes	2000	
Haiti					
1967–73	Deschapelles	5	Minehan	1974	
Peru					
1999	Lima	18	WHO/V&B/00.23	2000	
Puerto Rico					
1969–78	San Juan	2.9	Rossello	1981	
Venezuela					
2000	Caraboba	21	WHO/V&B/00.23	2000	
Trinidad and Tobago					
1976–82	San Fernando	4.6	Anatol	1985	
1982–85	Port-of-Spain	7.8	Kurvilla	1988	

Table 4: *(continued)*

Country/ dates of data collection	Site	Mean annual incidence (patients/year)	Author	Publication year	Reference to hospital activity
North America					
USA					
1921–46	Duluth	2.3	Magney	1947	
1928–64	Deroit	3.4	Ponka	1967	
1939–66	Duluth	2.8	Thomas	1972	
1930–85	Buffalo	10.6	Bruce	1987	
1942–71	Denver	12	Wayne	1973	
1944–60	Boston	6.5	Swenson	1962	
1945–58	New Orleans	7.4	Abbott	1962	
1949–70	Rochester	2.5	Ching	1970	
1952–67	Cleveland	7.4	Larsen	1974	
1953–69	Louisville	10	Schoo	1970	
1960–70	Ann Arbor	4.5	Kerry	1971	
1964–74	New London	2	Immordino	1977	
1964–74	Chicago	10.1	Janik	1976	
1970–85	Indianapolis	5.5	West	1987	
1970–74	Cincinnatti	20.2	Rosencrantz	1977	
1971–82	Kansas City	6	Spain	1984	
1977–88	Akron	14.2	Skipper	1990	
1990	Dallas	20	Meier	1996	
1990	Indianapolis	10	Meier	1996	
1987–96	Washington State	57	Brattan	2001	
1990–95	Sacramento	26	Kupperman	2000	
1998–99	Combined 19 states	669	Murphy	2001	
Canada					
1915–50	Toronto	16.4	Wansbrough	1952	
1957–68	Montreal	5.5	Racette	1971	
1957–78	Montreal	8.5	Ducharme	1982	
1958–74	Toronto	35	Ein	1975	
1959–68	Toronto	33.6	Ein	1971	
1977–79	Toronto	41	Janik	1981	
1979–96	Toronto	45	Daneman	1998	
1985–90	Toronto	37.6	Ein	1997	
1985–91	Montreal	30	Luks	1992	
1994–95	Toronto	63	Harrington	1998	
Europe					
Belgium					
1967–81	Brussels	7	Nobre	1984	
Czech Republic					
1950–54	Prague	16.8	Fiser	1967	
1955–66	Prague	11	Fiser	1967	
1966–71	Bratislava	10	Pohl	1983	
Denmark					
1936–65	Odense	6	Hansen	1968	
1975–89	Randers	1.5	Madsen	1991	
1976–86	Copenhagen	3	Kvist	1987	
Finland					
1960–69	Oulu	2.3	Kaltiala	1972	
1968–88	Oulu	2.1	Myllyla	1990	

Table 4: *(continued)*

Country/ dates of data collection	Site	Mean annual incidence (patients/year)	Author	Publication year	Reference to hospital activity
France					
1969–81	Rouen	18.3	Bachy	1983	
1974–85	Montpellier	13.6	Galifer	1987	
1976–86	Marseilles	11.3	Carcassonne	1987	
1982–86	Nantes	23.6	Heloury	1988	
1993–96	Paris	38	Le Masne	1999	
1982–86	Brest	17.5	Gaudin	1987	
Germany					
1942–86	Heidelberg	4.9	Benz	1987	
1959–73	Rostock	17	von Hille	1976	
1960–70	Linz/Donau	4.2	Muhlbacher	1990	
1970–88	Munich	5.6	Deindl	1990	
1978–88	Geburtstag	14	Hofmann	1990	
Hungary					
1977–87	Pecs	4.4	Nemeth	1988	
Israel					
1980–84	Jerusalem	10.5	Zamir	1984	
1985–95	Zerifin	10	Eshel	1997	
Italy					
1978–87	Varese	1.8	Salvatoni	1987	
1988–94	ASL FG/3	3	Marinaccio	1997	
Netherlands					
1968–88	Nijmegen	7	Reijnen	1990a	
1979–87	Emma	4.3	Stradmeijer	1989	
1990–95	Amsterdam	7.6	van Heek	1999	
Norway					
1960–76	Oslo	6.8	Nordshus	1979	
1961–74	Porsgrunn	2	Albrechsten	1976	
1983–92	Hordaland	14.2	Eikeset	1998	
Poland					
1964–78	Zakladn	9.1	Osemlak	1981	
Portugal					
1977–90	Coimbria	18	Cruz Lopes	1992	
Russian Federation/ Ukraine/former USSR					
1946–69		2.5	Vitebskii	1970	
1946–96		26.9	Sitkovskii	1997	
1946–80		28	Sitkovskii	1981	
1952–64	Pirogov	9.1	Raponski	1966	
1953–72	Donstsk	1.8	Zubov	1975	
1953–66		13.4	Iakovlev	1969	
1960–75		49.5	Khristich	1977	
1961–75		28.7	Kushch	1978	
1962–74		8.3	Akzhigitov	1976	
1964–65		8	Barsukov	1968	
1966–90		8.2	Neikov	1992	
1967–85		42.6	Novokreshchenov1987		
1974–87		56	Antoshkina	1990	
1975–85		2.8	Iakovlev	1988	
1976–86		24.8	Dmitryokov	1988	
1982–87		16.6	Oleinik	1989	
1983–86		45	Shchitinin	1989	
1984–91		31	Chepurnoi	1996	

Table 4: *(continued)*

Country/ dates of data collection	Site	Mean annual incidence (patients/year)	Author	Publication year	Reference to hospital activity
Spain					
1969–84	Corunna	4.7	Bautista	1988	
1970–82	Saragossa	11.8	Gracia	1985	
1983	Madrid	73	Barrio Gomez	1987	
1988–89	Vizcaya	64	Lesartes	1990	
Sweden					
1936–65	Gothenberg	14.3	Bjarnason	1968	
1951–65	Kristianstad	3.6	Silwer	1967	
1952–70	Stockholm	15	Gierup	1972	
1976–86	Malmo	11.3	Carstensen	1984	
Switzerland					
1972–79	Zurich	7.1	Fanconi	1982	
United Kingdom and Ireland					
1950–59	Glasgow	40	Strang	1959	
1950–59	Aberdeen	14.5	Steyn	1961	
1950–58	Edinburgh	11.7	Smith	1960	
1957–65	Dublin	7	Hood	1967	
1958–75	Dublin	7.8	Given	1979	
1959–68	Glasgow	28.8	Dennison	1970	
1967–76	Aberdeen	7.7	Pollet	1980	
1968–85	Edinburgh	17	Wilson-Storey	1988	
1969–78	Glasgow	20.9	Hutchinson	1980	
1968–80	Surrey	5.8	Man	1983	
1971–78	Bath	4.9	Thomas	1980	
1975–85	London	1.7	Poston	1985a	
1977–83	Dublin	9.4	Liu	1986	
1978–83	Belfast	12.4	Potts	1984	
1984–86	Leicester	11	Smith	1986	
1993–94	All England (NHS)	417	Gay	1999	
Yugoslavia					
1966–75	Novi Sad	5	Petrovic	1978	
Oceania					
Australia					
1962–68	Melbourne	29	Auldist	1970	
1969–84	Melbourne	37.6	Beasley	1986	
1976–88	Newcastle	11.7	Tangi	1991	
1979–84	Adelaide	25.6	Sparnon	1984	
1982–84	Perth	30.3	Mackay	1987	
1986–87	Melbourne	10	Phelan	1988	
1994	Sydney	3.3	Simon	1994	
New Zealand					
1964–80	Auckland	6.1	Raudkivi	1981	

* % patients with intussusception compared to all patients presenting with intestinal obstruction.
^ % patients with intussusception compared to all patients admitted for surgical causes.
# % patients with intussusception compared to all patients admitted to the hospital.
° % patients with intussusception compared to all patients treated by the hospital.

Chapter 5:
Clinical presentation and management of acute intussusception in infants and children: a global perspective

5.1 Age and sex characteristics

Intussusception is a condition that can affect people of all ages. However, there are important differences in its incidence, etiology and clinical manifestations between infants and adults. In published studies on intussusception there is significant variability in the age range of patient populations (Table 5). As this report focuses on infants and children with intussusception, data describing the clinical presentation and characteristics of infants and children with intussusception were extracted from publications covering a wider age range wherever possible. The majority of patients with intussusception reported in hospital-based paediatric studies were under 1 year of age (Table 5). A predominance of males was observed in almost all studies. It was not possible to compare the sex ratio of hospitalized intussusception patients with the baseline population or non-intussusception hospital admissions by means of the data available in published studies.

Africa

Male predominance was observed in almost all studies. The highest male to female ratio was 8:1 in Tunisia. The majority of cases occurred in infants less than 1 year of age; peak incidence occurred between 3 and 8 months of age (Isdale et al., 1986; Mayell, 1972; Archibong et al., 1994; Waldeyes et al., 1972; Momoh, 1987; Ajao, 1980; Adebamowo et al., 2000; Kedir et al., 1998).

Asia

Male predominance was observed in all reports, the widest ratio of 9:1 being reported in two studies from India (Table 5). In most reports a peak of cases of acute intussusception was observed in infants less than 1 year of age. Cases in infants aged under 2 months were rare and the median age was around 4 to 8 months.

Eastern Mediterranean

Studies from the Eastern Mediterranean reported a male predominance of patients presenting with acute intussusception, the male to female ratio ranging from 1.4:1 to 4:1. The majority of children presented when under 1 year of age; peak incidence occurred between 2 and 9 months of age.

Central and South America

There was a predominance of male patients presenting with intussusception (range 4.2:1 to 1.2:1). The condition occurred mainly in infants under 1 year of age. In Venezuela, 81% of patients were aged between 3 and 6 months; the range of ages at presentation was 3-60 months (WHO/V&B/00.23, 2000).

North America

A male predominance of patients presenting with intussusception was consistently reported in studies from the USA and Canada (Table 5). The mean age of presentation was 6.4 months (range 1-11 months) (Murphy et al., 2001). The annual rate of intussusception-associated hospitalization increased fivefold at 5 months of age and remained elevated until 7 months of age (Parasher et al., 2000). Infants who received oral rotavirus vaccine before the development of intussusception were younger at presentation (mean age 4.1 months, range 2-7 months) (Murphy et al., 2001).

Europe

A male predominance of cases was reported (range 1.1:1 to 5:1). The only exception was a subgroup of Arab children in a study from Israel which had a 1:1 male to female ratio (Eshel et al., 1997).The majority of patients with intussusception were infants aged under 1 year (mean 65%, range 33-90%) (Table 5). In England the highest incidence was in infants between 3 and 6 months of age (Gay et al., 1999).

Oceania

A male predominance of patients, of the order of 1.5:1 to 2:1, was reported. Three-quarters of patients with intussusception were less than 1 year of age at presentation.

Table 5: Age and sex distribution of patients with intussusception

Countries and authors	Age range of study group	Total number of cases studied	Age (% < 1 year age)	Sex ratio (male:female)	Etiology: % idiopathic (% mesenteric adenitis)
Africa					
Ethiopia					
Waldeyes	0-9yr	42	60	02:01	
Gudeta	0-12yr	72	70	1.5:1	97
Kedir	0-adult	33	39 <2yr	1.6:1 <2yr; 0.9:1 adults	55
Egypt					
El Barbari	0-10yr	180	84	1.5:1	93
Hadidi	0-child	147		1.9:1	
Ghana					
Archampong	0-19yr	41	65	1.9:1	100
Nigeria					
Odita	0-14yr	24	79	1.4:1	83
Akamaguna	0-15yr	35	74	2.2:1	
Mangete 1994	0-10yr	69	87	3.6:1	95(5%)
Ameh	0-adult	93	72		
Ajao	0-1yr	17	100	1.8:1	24 (53%)
Momoh	2mo-15yr	66	56	2.7:1<1yr; 4.9:1 >1yr	86
Nmadu (b)	0-1yr	47	100	4.2:1	100(36%)
Adejuyigbe	0-15yr	39	62	3.3:1	
Elechi	0-25yr	10	75	1.5:1	80
Archibong	0-15yr	66	82	1.4:1	
Ugwu	0-15yr	86	75	3.6:1	
Udezue	2mo-45yr	100	90	1.7:1	100
Bonkoungou	0-1yr	24	100	0.12569444	71
Nmadu (a)	0-50yr	85	55	3.3:1	93
Elebute	3mo-59yr	94	17	1.2:1	95
Adebamowo	0-adults	293		2.5:1	
Niger					
Harouna	0-1yr	11	100		
Senegal					
Diop	45days-6yr	22		6.3:1	82

Table 5: *(continued)*

Countries and authors	Age range of study group	Total number of cases studied	Age (% < 1 year age)	Sex ratio (male:female)	Etiology: % idiopathic (% mesenteric adenitis)
South Africa					
Postma	0-child	76	47	1.6:1	
Isdale	0-child	81		black 0.8:1; white 1.3:1	95
Mayell	0-12yr	223	63	1.7:1	93
Tunisia					
Saied	0-5yr	39	66	8:1	
Zaire					
Badibanga	0-2yr	26	65	2.7:1	
Zambia					
Munkonge	0-10yr	59	61	2:1	86
Asia					
Bangladesh					
WHO/V&B/00.23	5-12mo	70		08:01	
Myanmar					
Thein-Hlaing	1mo-12yr	41			10% ascaris
China					
Wang	3mo-12yr	427	70	1.8:1	
Guo	0-child	6396	66	1.8:1	
India					
Gopi	1mo-12yr	272	82	1.9:1	
Rao 1996	1yr-child	26	0	05:01	67
Belokar	0-14yr	21	38		
Singh	4mo-45yr	42	45	3.2:1	42
Madhusudhana Murty	2mo-12yr	60	81	03:01	87
Yadav	0-14yr	156	75	4.6:1	91
Taneja 1970	0-adults	50	52	2.3:1	82
Rao 1979	0-11yr	61	80	09:01	93
Chatterjee	0-65yr	47		2.6:1	78
Nadkarni	0-60yr	42	21	02:01	
Pandit	0-6yr	20	75	09:01	90

Table 5: *(continued)*

Countries and authors	Age range of study group	Total number of cases studied	Age (% < 1 year age)	Sex ratio (male:female)	Etiology: % idiopathic (% mesenteric adenitis)
Asia cont'd					
Talwar	0-9yr	75	73	03:01	92
Rattan	0-child	70		05:04:01	94
Jain	2mo-7yr	42	70 (4-6mo)	1.6:1	
Taneja 1968	0-12yr	12	75	05:01	58
Indonesia					
Lubis	2-27mo	39	95	02:01	
van Heek Jogykarata	1mo-9yr	35	61	01:01	83
van Heek Jakarta	1mo-11yr	103	86	1.8:1	88
Japan					
Ikeda	3mo-5yr	17	59	1.4:1	70 (49%)
Kato	3mo-5yr	36	72	05:01	
Republic of Korea					
Dietrick	0-adult	17	(11.7<2yr)	2.4:1	100
Suh	0-16yr	63	70	2.3:1	89
Kim	0-child	422	79	2.2:1	99
Malaysia					
Laidin	0-14yr	87	71	1.5:1	69
Taiwan, China					
Pang	1mo-14yr	228	71	1.4:1	88
Hsu	3mo-7yr	64	38	4.8:1	
Clarke	0-2yr	57	84	3.1:1	
Chung	1mo-15yr	361	61	1.6:1	93
Lee CT 1988	0-8yr	167	83	1.8:1	90
Lee MT 1973	2mo-7yr	100	70	1.6:1	95 (24%)
Thailand					
Sutthiwan	0-12yr	51	88	1.7:1	86
Viet Nam					
WHO/V&B/00.23	0-1yr	472-722	100	1.5:1	

Table 5: *(continued)*

Countries and authors	Age range of study group	Total number of cases studied	Age (% < 1 year age)	Sex ratio (male:female)	Etiology: % idiopathic (% mesenteric adenitis)
Eastern Mediterranean					
Lebanon					
Bitar	2mo-12yr	69	85	2.5:1	96
Iran					
Farpour	0-adult	56	66	4:1	88
Kuwait					
Issa	0-child	233	93	1.7:1	92
Qatar					
Dawod	0-2yr	67	89	2.5:1	94
Saudi Arabia					
Mohamed	0-adult	6		2:1	
Central and South America					
Brazil					
Artigas	0-4yr	14			86
Chile					
Fadda	0-child	60	72	1.5:1	75
Haiti					
Minehan	0-child	30		2:1	
Puerto Rico					
Rossello	4mo-60yr	29		1.6:1	
Venezuela					
WHO/V&B/00.23	0-1yr	21	81% 3-6mo	4.2:1	
Trinidad and Tobago					
Anatol	1mo-10yr	37	100	1.2:1	95
Kuruvilla	3mo-9yr	84	87	1.2:1	98

Table 5: *(continued)*

Countries and authors	Age range of study group	Total number of cases studied	Age (% < 1 year age)	Sex ratio (male:female)	Etiology: % idiopathic (% mesenteric adenitis)
North America					
USA					
Abbott	3wks-83yr	96	58	2:1	92
Barr	1mo-6yr	60	73		93
Bruce	0-7yr	583	63	2:1	90
Ching	0-15yr	53	38	1.9:1	70
Immordino	0-9yr	20	65	3:1	85 (15%)
Kerry	0-adult	50	22		87 (32%)
Kupperman	1mo-5yr	143	96 <2yr	2.2:1	
Larsen	0-child	111	58	2.3:1	67 (14%)
Meier (Texas)	2mo-2yr	50	86	2.1:1	100
Meier (Indiana)	2mo-10yr	50	68	2.6:1	84
Ponka	0-75yr	123	36	2.2:1	94
Schoo	0-13yr	160	40		89 (19%)
Skipper	0-child	157		2.1:1	89
Spain	0-12yr	68	75	2.3:1	93

Table 5: *(continued)*

Countries and authors	Age range of study group	Total number of cases studied	Age (% < 1 year age)	Sex ratio (male:female)	Etiology: % idiopathic (% mesenteric adenitis)
Swenson	0-7yr	97	66	2.7:1	94 (3%)
Thomas	0-13yr	86	63	1.3:1	
Wayne	2wk-18yr	344	52	1.9:1	92
West	2mo-22yrs	97	59	1.6:1	89
Canada					
Daneman	2mo-15yr	876		2.3:1	93
Ein 1971	0-child	354	56	2:1	92
Ein 1997	0-child	188		1.5:1	99.6
Luks	2mo-15yr	180	63	1.9:1	
Racette	0-child	55	47	1.9:1	80
Wansbrough	0-14yr	575		1.8:1	
Europe					
Belgium					
Nobre	3mo-10yr	100	52	2:1	95
Czech Republic					
Fiser	0-child	126		2:1	90
Pohl	0-child	153			79
Denmark					
Hansen	0-15yr	196	37	1.8:1	95
Kvist	3-66mo	30	63	2:1	(88)
Finland					
Kaltiala	0-adult	23	70	4.9:1	
Myllya	1mo-14yr	41		2.2:1	95
France					
Bachy	0-child	220	54		
Carcassone	0-7yr	113	60	1.5:1	92 (32%)
Heloury	0-child	118	61	2.8:1	96
Le Masne	10days-9yr	113		1.6:1	96 (3%)
Germany					
Staatz	2mo-18yr	148		1.7:1	73(19%)

Table 5: *(continued)*

Countries and authors	Age range of study group	Total number of cases studied	Age (% < 1 year age)	Sex ratio (male:female)	Etiology: % idiopathic (% mesenteric adenitis)
Israel					
Eshel	0-child	90	92	1:1 Arabs, 1.2:1 Jews	99
Freund	0-child	49	70	1.4:1	75
Zamir	0-child	42			93
Italy					
Baracchini	1mo-2yr	30	90	1.1:1	87
Bardini	0-5yr	43	74	2:1	
Marinaccio	0-child	21	89	1.7:1	62
Netherlands					
Reijnen 1990b	0-15yr	140	56 < 2yr	2:1	78
van Heek	3mo-7yr	38	68	4.4:1	90
Norway					
Nordshus	0-child	108	64	2:1	87 (55)
Poland					
Osemlak	0-12yr	121	80		
Portugal					
Cruz Lopes	0-child	233	88	2:1	88
Russian Federation/ Ukraine/former USSR					
Akzhigitov	0-child	100	85	2:1	81
Oleinik	0-child	83	72	2:1	
Spain					
Barrio Gomez de Aguere	0-child	75	72	2:1	
Bautista	0-child	70	88	1.7:1	
Sweden					
Bjamason	0-child	428	63	2:1	
Gierup	0-12yr	288	33	2:1	94

Table 5: *(continued)*

Countries and authors	Age range of study group	Total number of cases studied	Age (% < 1 year age)	Sex ratio (male:female)	Etiology: % idiopathic (% mesenteric adenitis)
United Kingdom					
Dennison	0-10yr	288	69	2:1	
Given	0-child	141	67	2:1	
Hood	1mo-13yr	63	60	1.2:1	81
Hutchinson	1mo-10yr	209	61	2:1	89
Liu	0-child	72	94	2.3:1	
Man	0-6yr	75	76	2.1:1	98
Pollet	2mo-11yr	77	48	2.7:1	93
Potts	0-child	62	81	2.4:1	
Steyn	0-6yr	145	53	1.5:1	
Strang	0-child	400	63	2:1	
Wilson-Storey	9wks-13yr	125	71	1.2:1	
Yugoslavia					
Petrovic	0-child	53	62	3.4:1	
Oceania					
Australia					
Auldist	0-child	203	74	2:1	88
Beasley	0-child	602	54	1.8:1	90
Sparnon	0-14yr	128	75 < 2yr	1.5:1	92
Tangi	0-child	153	76	1.5:1	95
New Zealand					
Raudkivi	0-child	96	75	2:1	88

5.2 Ethnicity

The potential role of ethnic differences in determining variations in the incidence of intussusception was addressed in nine studies. As the studies were all hospital-based it is possible that any differences observed reflect differences in the ethnic population admitted to specific hospitals or different opportunities to access health care.

In Malaysia a comparison was made of the annual incidence of intussusception in the three main ethnic groups attending the same hospital. A tenfold higher annual incidence was observed in ethnic Malays (55.8% of cases) than in Indians (5.7% of cases) (Laidin et al., 1982). The authors proposed that the later age of weaning and the poor nutritional status of the Indian population could explain this difference.

In Trinidad and Tobago a higher annual incidence of intussusception was reported in infants of African descent (62% of cases) than in Indians (17% of cases) and infants of mixed racial origin (20% of cases) (Kuruvilla et al., 1988).

In Israel the incidence of acute intussusception was more than twice as high in Jews as in Arab infants attending the same medical centre (Eshel et al., 1997). The distribution between the sexes was equal in Arab infants but among Jewish infants there was a 1.2:1.0 male predominance.

In Kuwait the incidence of intussusception is lower than in neighbouring countries (Issa et al., 1988). While Kuwaitis comprise approximately 40% of the population of Kuwait, only 29% of the patients diagnosed with intussusception were Kuwaitis (Issa et al., 1988). It remains unclear whether this reflects demographic or ethnic factors.

The presentation and management of intussusception at a secondary care paediatric hospital in Jakarta, Indonesia, were compared with those at a tertiary care hospital in Amsterdam, the Netherlands (van Heek et al., 1999). No difference was found in the proportion of surgical admissions attributable to intussusception (1.2%), and no significant racial difference was identified in the clinical presentation of intussusception in infants attending the hospitals.

In the USA an elevated proportion of infants with intussusception had Hispanic or Black ethnic backgrounds (odds ratios 2.3 and 2.0 respectively) (Murphy et al., 2001). A slight increase in incidence was also identified in Black infants in a study from New Orleans (Abbott et al., 1962). In Indiana, intussusception-associated hospitalizations were higher among Black infants (50 per 100 000: relative risk 1.8, 95% confidence interval 1.2–2.9) and infants of other races (217 per 100 000: relative risk 8.0, 95% confidence interval 4.6–14.1) than in White infants (Parasher et al., 2000). Similar rates of hospitalization for intussusception were observed in Black and White infants in California and Georgia; however, a higher rate of hospitalizations was observed in infants of other races (Parasher et al., 2000). No differences were identified in relation to ethnic background in a study based in Buffalo, New York (Bruce et al., 1987).

5.3 Seasonal variation in presentation of intussusception

Seasonal variation in the incidence of intussusception was inconsistently reported. In some studies, variations in incidence were described in relation to the calendar months, while in others it was related to the seasonal pattern. Whereas in tropical zones the seasons were described as either wet or dry, they were referred to as summer, autumn, winter and spring in temperate zones. Seasonal variability was also related to the peak incidence of admissions of patients with acute gastroenteritis. However, data supporting this association were rarely provided.

Africa

Seasonal variation in the presentation of acute intussusception was reported in a number of studies. In most studies from Nigeria the majority of patients presented in the dry summer period (Elebute et al., 1964; Ugwu et al., 2000; Akamaguna et al., 1985; Mangete et al., 1993, 1994; Odita et al., 1981), although this was not true in a study reported by Solanke (1968). This coincided with an increase in the incidence of diarrhoeal diseases in at least one study (Mangete et al., 1993). In a study from South Africa, two peaks were identified, at the end of summer and the end of winter, both coinciding with the peak incidence of respiratory tract infections and diarrhoeal diseases (Mayell, 1972). Yet in another study from South Africa the lowest incidence was observed during the midsummer months (Isdale et al., 1986). In Zimbabwe, patients presented mainly in spring and summer and there were unexplained peaks in presentations (Chapman, 1973). Twenty-one per cent of patients in this study had a history suggestive of acute gastroenteritis, and one patient had a stool culture that was positive for *Shigella*. In Egypt the peak months of presentation of intussusception were April and May, coinciding with the peak incidence of respiratory tract infections and gastroenteritis (El-Barbari et al., 1978). In Senegal, 64% of patients with intussusception presented during the cold season (Diop et al., 1975).

Asia

In India an increased incidence of intussusception was reported in the summer months (WHO/V&B/00.23, 2000). Forty per cent of patients in a study from Chandigarh presented in March or April (Yadav, 1986). Another study reported an increase in intussusception admissions in April and May associated with the peak incidence of gastroenteritis (Talwar et al., 1973). In Hyderabad a slight increase in presentations was reported in February as well as in May to June but this did not correspond to the peak rates of respiratory tract infections or gastroenteritis in the area (Madhusudhana Murty et al., 1975). In Bangladesh a distinct peak in the winter months was reported (WHO/V&B/00.23, 2000).

During the 1950s and 1960s in Taiwan, China, 67% of patients presented in the first six months of the year, which was also the peak period of adenovirus infection (Clarke, 1969). In 1980-1985 cases of intussusception in Taipei peaked during March, May and June (Lee CT et al., 1988). However, other studies from Taiwan in the 1980s and 1990s failed to demonstrate a clear seasonal pattern in the presentation of intussusception (Pang, 1989; Hsu et al., 1998).

In Thailand a sustained increase in the number of cases of intussusception was noted between September and January and again in April. These increases coincided with the cool summer months and the peak incidences of upper respiratory tract infection and gastroenteritis (Sutthiwan et al., 1982). No seasonal variation was noted in Malaysia (Laidin et al., 1982). In Viet Nam a slight increase in incidence was observed in December and February (WHO/V&B/00.23, 2000).

Eastern Mediterranean

In some studies from Eastern Mediterranen a seasonal variation in the presentation of acute intussusception was reported, a peak occurring in spring and summer (Dawod et al., 1992; Issa et al., 1988). In Qatar a cluster of presentations occurred in winter and summer, while in Lebanon two peaks were observed in spring and summer (Dawod et al., 1992). In Kuwait a peak in incidence was observed in spring (Issa et al., 1988).

Central and South America

No seasonal variation was observed in studies from Trinidad and Tobago, Venezuela and Puerto Rico (Kuruvilla et al., 1988; Anatol, 1985; Rossello et al., 1981; WHO/V&B/00.23, 2000). In Chile an increased incidence was reported in September and again between December and March (Fadda et al., 1970). In Haiti an increase was observed in late spring and early summer (Minehan et al., 1974).

North America

In New York State, hospitalizations for intussusception were evenly distributed throughout the year and there was no clear association with the seasonal distribution of hospitalization for rotavirus diarrhoea (Rennels et al., 1998). No consistent seasonal trend was observed in hospitalizations for intussusception-associated disease in data from the Indian Health Service, the states of Indiana and California and the National Hospital Discharge Survey (Parasher et al., 2000). However, an increase in the incidence of intussusception was observed in spring and summer in five other studies in the USA (Spain et al., 1994; Schoo et al., 1970; Bruce et al., 1987, Larsen et al., 1972; Meier et al., 1996). The seasonal peak did not coincide with the peak incidence of respiratory tract infections and gastroenteritis in a study from Buffalo, New York (Bruce et al., 1987). In Canada a peak incidence in the winter months was reported in one study (Racette et al., 1971). An increase in the incidence of intussusception cases was identified in May to June in 1971, whereas a 1997 study in the same region reported peak incidence in January and July (Ein et al., 1971, 1997).

Europe

An increased number of cases was observed in the spring and summer months in nine studies from Scotland, Italy, Germany, France, Poland and Spain (Strang, 1959; Dennison et al., 1970; Bardini, 1967; Baracchini et al., 1995; Staatz et al., 1998; Carcassonne et al., 1987; Le Masne et al., 1997; Osemlak et al., 1981; Bautista et al., 1988), but no significant seasonal variation was observed in three further studies from Scotland (Hutchinson et al., 1980; Steyn et al., 1961; Wilson-Storey et al., 1988). In Israel, Eshel et al. (1997) reported an increase in presentations in the warmer months from April to October, while Weisz et al. (1994) reported an increase in spring and autumn.

Oceania

An elevated proportion of patients presented in summer according to two reports from Australia and New Zealand (Raudkivi et al., 1981; Sparnon et al., 1984). No seasonal variation was observed in a hospital-based report from Australia (Simon et al., 1994).

5.4 Etiology

Discussion on the etiology of intussusception is limited to information that directly relates to the clinical epidemiology of the condition in developing and developed countries. The definition of the term "idiopathic" intussusception varied between studies. In most studies this term is used to describe cases where no specific abnormality of the intestine known to cause intussusception, such as Meckel's diverticulum or a polyp, has been identified at surgery. However, in some studies, mesenteric lymphadentitis is cited as an identifiable cause and is therefore excluded from the idiopathic group. Wherever possible these data have been separated in Table 5. As the rate of surgical intervention is declining in intussusception, the relevance of non-specific findings such as mesenteric adenitis may be difficult to establish in the future, except in cases of severe or prolonged intussusception requiring surgery. Although a seasonal association between the incidence of intussusception and acute gastroenteritis or respiratory tract infection has been observed in some studies, this is certainly not universal. There is little evidence to implicate a single viral, bacterial or parasitic organism in the majority of cases of intussusception in currently available studies.

Africa

In the studies from Africa most episodes of acute intussusception in infants were not associated with definable causes. Mesenteric adenitis was described in 21 to 53% of cases in the three studies in which this feature was reported (Ajao, 1980; Udezue, 1988; Bongoungou et al., 1999). If the cases of mesenteric adenitis with no identifiable etiology and idiopathic cases are combined, 71-100% of reported cases of acute intussusception in infants and children are not associated with a definable cause (Table 5). A history suggestive of acute gastroenteritis prior to presentation with intussusception was obtained in 21% of patients in one series (Chapman 1973). In Egypt, 46% of patients had a history of prior gastroenteritis (30%) and/or respiratory tract symptoms (20%) (El-Barbari et al., 1978). The increased incidence of intussusception in the dry months coincided with the peak incidence of acute diarrhoeal illness and respiratory tract infections, suggesting that infectious agents or an inflammatory reaction in response to infection may play a role in the etiology of acute intussusception (Mangete et al., 1994; Mayell, 1972). This link has not yet been proven, nor is this temporal relationship between infection and intussusception consistent in all studies (Isdale et al., 1986).

In south-western Nigeria, a higher incidence of caeco-colic intussusception, particularly in adults, has been reported. Various explanations have been postulated for this unusual pattern. Sixty-four per cent of Nigerian cadavers have a free and mobile caecum and ascending colon, suggesting an increased risk of intussusception (Solanke, 1968). In this area the traditional staple diet consists of plantain (*Musa paradisiaca*), which contains high levels of serotonin (Ugwu et al., 2000).

It has been suggested that this may adversely influence intestinal neuromuscular coordination and thereby increase the risk of intussusception. Parasitic infestations, in particular with *Trichuris trichiura* and amoebiasis, have also been associated with caeco-colic intussusception (Solanke, 1968; Waldeyes et al., 1972). In a study focusing on colonic intussusception in children, *Ascaris* infestation was identified in 9 of 16 children presenting with caeco-colic intussusception (Davies et al., 1978). A mass of *Ascaris* worms was reported close to the apex of the intussusception in a young adult with jejuno-jejunal intussusception (Elebute et al., 1964). Acetylcholine has been reported to produce intussusception in experimental animals (Laborit, 1949). The treatment of acute diarrhoeal illness with drugs containing acetylcholine has been also been postulated as a precipitating cause of intussusception. This theory may provide another possible explanation for an association between a prior history of gastroenteritis and intussusception in some patients (Elebute et al., 1964).

Asia

An idiopathic etiology was reported in 42 to100% of patients in 20 studies. An association with a prior respiratory infection or acute gastroenteritis was reported in some studies. In the Republic of Korea, 21% of patients had prior symptoms of a respiratory tract infection and 10% had diarrhoea prior to presentation with intussusception (Kim et al., 1989). In another study from the same country, however, no association was observed between intussusception and symptoms suggestive of prior gastroenteritis (Suh et al., 1968). In Jakarta, prior histories of respiratory infection and gastroenteritis were recorded in 51% and 61% of patients respectively who presented to an urban children's hospital (van Heek et al., 1999).

In Taiwan, China, a history of fever, respiratory tract symptoms or gastroenteritis was documented in 63% of patients presenting with intussusception (Hsu et al., 1998). In another study from Taiwan, 20% of patients presenting with intussusception had a prior history of respiratory tract infection or gastroenteritis and 51% described these symptoms at the time of presentation; mesenteric adenitis was observed in 24% of these patients (Lee et al., 1988).

The diagnostic difficulty in differentiating between acute gastroenteritis or bacillary dysentery and intussusception is highlighted in a study from India where 17% of patients diagnosed with intussusception presented with rectal bleeding alone. These patients had been treated for three to five days for bacillary dysentery before the diagnosis of intussusception was established. The authors in this study recommended that intussusception should be excluded in patients with acute rectal bleeding or if abdominal distension followed an episode of gastroenteritis or enterocolitis. The delay in appropriate treatment caused by misdiagnosis contributes to the resection rate and mortality (Jain et al., 1990). In another study, 52% of patients had a preceding history of diarrhoea and had been treated with antidiarrhoeal agents (Yadav, 1986).

The potential role of specific infectious agents in the pathophysiology of intussusception has been reported in studies from Asia. Adenovirus infection was first linked to intussusception in children in Taiwan, China (Clarke, 1969). In a recent study from Taiwan, 44% of patients with intussusception shed adenovirus in throat or rectal specimens compared to only 3.8% of healthy controls. Acute primary viral infection was identified in 65% of intussusception patients in whom paired sera were

available (39.5% adenovirus, 9.3% human herpes virus–6, 11.6% human herpes virus–7, 4.7% Ebstein Barr virus) (Hsu et al., 1998). Adenovirus genome was detected in four of nine mesenteric lymph nodes; in this study, 75% of the patients with primary adenovirus infection, confirmed by seroconversion, were more than 1 year old. It is unclear from these data whether intussusception in children older than 1 year is more likely to be associated with an acute viral infection, or whether changing hygiene standards have impacted on the pattern of age of presentation of intussusception. *Yersinia pseudotuberculosis* infection was associated with intussusception in three boys from the Republic of Korea (Koo, 1996). *Ascaris lumbricoides* was reported to be an important etiological factor in the development of intussusception in 2 of 26 patients presenting with intussusception in Rangoon Children's Hospital, Myanmar (Thein-Hlaing et al., 1990).

Increased serum gastrin and cyclic adenosine monophosphate levels were reported in children with intussusception in China. Animal studies showed that gastrin increased intestinal peristalsis and relaxation of the ileocaecal sphincter. It was hypothesized that hypergastrinaemia had a causative role in the development of intussusception (Jin et al., 1996).

In a study from the Republic of Korea a mobile caecum was postulated as a predisposing factor for the development of intussusception. Eighty-eight per cent of cases were over the age of 2 years and most patients had a subacute or chronic presentation without intestinal obstruction. A mobile caecum was observed in 10 of 14 patients with subacute or chronic intussusception (Dietrick et al., 1965). It is unclear whether the mobile caecum was primarily associated with the development of intussusception or resulted in a subacute or chronic presentation without the development of vascular occlusion.

The nutritional status of infants presenting with intussusception was not well documented in most studies from Asia, although normal nutritional status was reported in all children presenting with the condition to the All Indian Institute of Medical Science, New Dehli (WHO/V&B/00.23, 2000). Similarly, 87% of patients with intussusception were reported to be well nourished in a study from Medan, Indonesia (Lubis et al., 1990).

Eastern Mediterranean

Most patients presented to hospitals with no identifiable cause of their intussusception. However, a history of gastroenteritis or respiratory tract infection was common. In Lebanon, 60% of patients had a history of respiratory tract symptoms or gastroenteritis (Bitar et al., 1969). In Iran over 50% of patients had a history of gastroenteritis or respiratory tract symptoms (Farpour et al., 1970). The proportion of patients who had a recent history of infection was lower in Qatar (24%).

Central and South America

Most cases of acute intussusception were idiopathic. In Trinidad and Tobago, 24% of infants had a prior history of gastroenteritis and 11% had a history of respiratory tract infection (Anatol, 1985). In Puerto Rico a pathological lesion was identified in only two patients under 5 years of age (Meckel's diverticulum, neuroblastoma) (Rossello et al., 1981). In contrast, a pathological lead point was identified in almost half of patients aged over 5 years, and half of them were malignant

(Rossello et al., 1981). Parasitic infestation with *Ascaris*, *Entamoeba histolytica*, *Giardia* and hookworm was documented in 27% of children presenting with intussusception in Haiti; however, this was similar to the background incidence of infestation in the normal paediatric population of Haiti (Minehan et al., 1974).

North America

No identifiable cause of intussusception was identified in the majority of patients diagnosed and treated in North America (range 67-100%) (Table 5). In two studies, mesenteric adenitis was reported in 19% and 32% of patients (Kerry, 1971; Ponka, 1967). A prior history or concurrent presentation with gastroenteritis or respiratory tract symptoms was reported in one-third of patients in Indianapolis, 47% in Michigan, 20% in Toronto, but only 7% in Boston (West et al., 1987; Kerry, 1971; Swenson et al., 1962; Ein et al., 1997).

An association between vaccination with RRV-TV (tetravalent rhesus-human ressortant rotavirus vaccine) and intussusception among otherwise healthy infants was reported in a study combining data from 19 states in the USA. The infants who developed intussusception following the administration of oral rotavirus vaccine were more likely to be formula-fed than breast-fed and they had less often started consuming solid food before the referral date. The possibility was suggested that the putative enterotoxins derived from strains in RRV-TV resulted in abnormalities of intestinal peristalsis which contributed to the development of intussusception (Murphy et al., 2001).

Europe

No specific etiology was identified in most patients (range 60 to 96%). Mesenteric adenitis was found in 88% of patients in a study from Denmark but was present in only 3% in one from France (Kvist, 1984; Heloury et al., 1988). A prior history of symptoms of an upper respiratory tract infection was observed in between 5 to 39% of patients in selected studies (Man et al., 1988; Wilson-Storey et al., 1988; Staatz et al., 1998; Le Masne et al., 1998; van Heek et al., 1999, and Israel (29%) (Dawod et al., 1992; Eshel et al., 1997). Cervical, axillary and inguinal lymphadenopathy were found on clinical examination in 26% of patients with intussusception in one study (Pollet et al., 1980). In a study in Germany, 61% of patients had abnormalities on stool microscopic examination including adenovirus, *Yersinia* and *Staphlococcus aureus* (Staatz et al., 1982). The role of birth trauma, with possible spine and spinal vessel injury, was postulated in one study from the Russian Federation (Morozov, 1988).

Oceania

Intussusception was described as idiopathic in over two-thirds of patients reported in studies from this region. A history of acute respiratory tract infection or gastroenteritis, prior to presentation with intussusception, was frequently observed (in 37% of cases by Mackay et al., 1987; 27% by Beasley et al., 1987; 24% by Auldist, 1970; and 28% by Sparnon et al., 1984).

5.5 Clinical presentation

As the majority of studies on intussusception are hospital-based retrospective chart reviews, the accuracy of the data is highly dependent on the quality of the description of symptoms and signs recorded in a legible manner. Specific symptoms or signs, such as lethargy and pallor, are reported in a high proportion of patients in some studies but not at all in others. While this may be interpreted as demonstrating variation in the clinical presentation of intussusception in different regions, it may also reflect a difference in local awareness of these symptoms by particular clinicians or hospital staff. Abdominal pain or the perception of pain by parents was frequently reported in studies from developed countries but less often recorded in studies from developing countries. This may reflect differences in parental perceptions or accessibility to health care services. A comparatively high proportion of patients in studies from developing countries presented with symptoms suggestive of more severe complications of intussusception, such as shock or bowel ischaemia. This may reflect problems of delayed diagnosis and/or access to paediatric health care facilities.

Textbook clinical definitions, such as that of the classic triad of intussusception, present a group of symptoms and signs that are easy to recall but may delay diagnosis in patients lacking them. If a group of symptoms and signs can be demonstrated to reliably identify patients with intussusception they may be an important clinical tool for health care workers. The diagnostic accuracy of these specific groups of symptoms, in terms of sensitivity and specificity, has been summarized in Table 7.

Clinical symptoms

Africa

The most common symptoms at presentation in infants were vomiting, abdominal pain and rectal bleeding or bloody stool (Tables 6 and 7). However, all three of these symptoms were observed in fewer than half the patients with surgically proven intussusception (15% by Adebamowo et al., 2000; 37% by Mahfoudh et al., 1993; 41% by Postma et al., 1985). The presence of abdominal pain, vomiting, bloody stool and a palpable abdominal mass was reported in 38% of infants and 31% of children with intussusception in one series. In this study, rectal bleeding and abdominal or rectal mass were identified in 60% of infants and 69% of children with intussusception. Seventy per cent of patients in this study developed rectal bleeding within 12 hours after the onset of illness, suggesting that this was an early and important clinical marker (Momoh, 1987). However, in another study from Nigeria the presence of abdominal pain, rectal bleeding and an abdominal mass was observed in only 16% of patients (Mangete et al., 1994).

Diarrhoea was observed in about one-third of patients (mean 34%, range 13-70%) (Table 6). The incidence of constipation varied widely between studies from 0% (Isdale et al., 1986) to 60% (Mangete et al., 1994). The reason for this wide disparity is unclear. In the three studies where the nutritional status of patients presenting with intussusception was noted the incidence of mild to severe malnutrition was less than 30% (Table 6). Irritability of infants was mentioned in only one study, where it was reported as affecting the majority of infants.

Asia

Vomiting was the most consistent symptom observed in 38-100% of patients in 20 studies (Table 6). Rectal bleeding or bloody diarrhoea was also frequently reported (range 17-100%). Abdominal pain occurred in 39-90% of patients from the 15 studies reporting this symptom (Table 6). However, 17% of patients from a study in India had painless rectal bleeding associated with intussusception (Jain et al., 1990). The incidence of diarrhoea varied from 17 to 100%, while constipation was an important presentation in some studies (Table 6).

The presence of the classic triad of vomiting, abdominal pain and rectal bleeding was reported to occur in 82% of patients in Taiwan, China (Pang et al., 1989) (Table 7). In the Republic of Korea, two-thirds of patients presented with the classic triad of symptoms (Kim et al., 1989). Two studies from India reported that the triad of symptoms occurred at presentation in 50-65% of patients (Rattan et al., 2000; Jain et al., 1990). Only 10% of patients in Malaysia and 14-20% of patients in Hong Kong, China, reported these three symptoms at presentation (Laidin et al., 1982; Peh et al., 1997). The presence of vomiting, abdominal pain, bloody stool or rectal bleeding and an abdominal mass was identified in 26% and 17% of patients in two studies from Taiwan, China (Lee et al., 1988; Chung et al., 1994).

Eastern Mediterranean

Vomiting was the most frequently reported symptom occurring in 38-95% of patients presenting with intussusception; abdominal pain occurred in about two-thirds of patients; rectal bleeding was reported at presentation in over 50% of patients (Table 6). The combination of vomiting and rectal bleeding was observed in 85% of patients in Lebanon (Bitar et al., 1969). The classic triad of vomiting, abdominal pain and rectal bleeding was identified in approximately half the patients in Qatar (Dawod et al., 1992) and Lebanon (Bitar et al., 1969) (Table 7).

Central and South America

Vomiting was observed in most patients (range 65-100%) and was the first symptom in 62% of patients in Trinidad (Kuruvilla et al., 1988). A history of rectal bleeding or bloody diarrhoea was reported in 63-100% of patients but this was not a common presenting symptom (10%) (Kuruvilla et al., 1988). Abdominal pain was frequently observed in most studies (Kuruvilla et al., 1988, Fadda et al., 1970) (Table 6). The identification of patients with suspected intussusception by using the classic triad of vomiting, abdominal pain and rectal bleeding was considered unreliable, being reported in only 14% and 36% of patients in the two studies from Trinidad and Tobago (Kuruvilla et al., 1988; Anatol, 1985) (Table 7).

North America

Vomiting was frequently reported at presentation, occurring in 50-94% of patients. Abdominal pain was reported in 48-91% of patients (Table 6). The absence of pain in 15% of patients in one study was associated with an increased duration between the onset of symptoms and diagnosis and an elevated rate of complications (Ein et al., 1971).

A history of rectal bleeding or blood in the stool was reported in 27-84% of patients (Table 6). Rectal bleeding, either on history or physical examination, was identified as a significant independent predictor of intussusception (Kupperman et al., 2000). In a multivariate analysis aimed at determining predictors of intussusception, a highly suggestive abdominal X-ray, rectal bleeding, male sex and a history of emesis were identified ($P<0.05$, $r^2 = 0.46$) (Kupperman et al., 2000). The presence of the classic triad of vomiting, abdominal pain and rectal bleeding was observed in three-quarters of patients from Duluth, but was reported in only 21-32% of patients in three other studies from North America (Thomas, 1972; Bruce et al., 1987; Racette et al., 1971; Newman et al., 1987) (Table 7).

Lethargy was observed in 22-45% of patients in the three studies reporting this symptom (Table 6). A normal nutritional status was observed in most patients (Bruce et al., 1987; Janik et al., 1981).

Europe

Vomiting was a presenting symptom in 20-100% of patients reported in European studies. Abdominal pain was a consistent symptom in most patients presenting with acute intussusception to hospitals (range 40-100%) (Table 6). A history of rectal bleeding was consistently reported but it did not predict the viability of the bowel in one study (Potts et al., 1984) (Table 6).

The classic triad of symptoms was observed in 10% to over 66% of patients reported in the studies that documented the presence of the triad (Table 7). Over two-thirds of patients were reported as presenting with abdominal pain, vomiting, rectal bleeding and an abdominal mass (Dennison et al., 1974), but this rate has not been replicated in subsequent studies from the same or neighbouring regions (Hutchinson et al., 1980; Pollet et al., 1980). Over one-third of infants presented with screaming, vomiting or apathy in one study (Eshel et al., 1997).

Patients diagnosed with intussusception tended to present to hospital within 24 hours following the onset of symptoms (range 16-88%); the resection rate and mortality were significantly higher in patients presenting 48 hours or more after the onset of symptoms (Table 9).

Oceania

Vomiting was a common presenting symptom in over three-quarters of patients with intussusception (range 74-95%) (Table 6). Abdominal pain or irritability was frequently encountered (range 49-93%). Rectal bleeding was present in about half the patients at admission (range 44-67%), while diarrhoea was reported in about 10%. A case of intussusception presenting as profound lethargy highlighted the importance of this symptom (Godbole et al., 2000).

The classic triad of symptoms was reported in 20% of patients in a study from New Zealand and in 45% in one from Australia (Raudkivi et al., 1981; Sparnon et al., 1984) (Table 7). The presence of vomiting, abdominal pain, rectal bleeding and an abdominal mass was reported in 17% and 23% of patients in two Australian studies (Sparnon et al., 1984; Tangi et al., 1991).

Table 6: Clinical symptoms (% patients with each symptom)

Country	Abdominal pain	Vomiting	Rectal bleeding or bloody stool	Diarrhoea	Constipation	Irritability / lethargy	Malnutrition
Africa							
Ethiopia							
Gudeta	53	80					24
Kedir		100	100				22
Waldeyes	"Majority"	86	88			"Majority" irritable	
Nigeria							
Adebamowo	23	83	64	21	25		
Mangete (a)	84	76	46	22	68		
Momoh	46<1yr, 69>1yr	76<1yr,72>1yr	62	30<1yr,17>1yr	30<1yr,4>1yr		
Ameh	83	95	81	62	33		
Elechi	80		80				
Odita		87	62				
Akamaguna	50	86	60				
Nmadu (b)	89	98	89	70	30		
Adejuyighe	62	85	59	3	44		
South Africa							
Davies	73	78	84				
Postma	58	93	82	53			
Isdale	17Black,73White	88Black,83White	86Black,63White	19Black,10White	0Black, 13White		
Mayell	70	88	61	28			27
Zaire							
Badibanga	50	88	85	34			
Zambia							
Munkonge	83	72	66				

Table 6: *(continued)*

Country	Abdominal pain	Vomiting	Rectal bleeding or bloody stool	Diarrhoea	Constipation	Irritability / lethargy	Malnutrition
Asia							
Hong Kong, China							
Peh	50						
India							
Taneja (b)	53	82	59	53	35		
Cahtterjee	64	81	91				
Pandit			50	20			
Talwar	79	72	73	24	48		
Rao		100	80	46			
Singh	50	38	17	19	26		
Madhusudhana	73	80	80	17			
Yadav		100	82	52			
Taneja (a)	67	75	50	58			
Jain	86	57	67	38			
Indonesia							
Lubis		82	87	23			13
Van Heek (rural)	39	91	100				
Van Heek(urban)	35	86	79				
Japan							
Ikeda		100	35				
Kato		83	86				
Republic of Korea							
Suh	86	83	75	54			
Kim	88	84	44				
Malaysia							
Laidin	35	94	53				
Taiwan, China							
Chung	90	81	69				
Thailand							
Sutthiwan	43	82	82	37	4		12

Table 6: *(continued)*

Country	Abdominal pain	Vomiting	Rectal bleeding or bloody stool	Diarrhoea	Constipation	Irritability / lethargy	Malnutrition
Eastern Mediterranean							
Lebanon							
Bitar	>50	>85	>85				
Iran							
Farpour	64	93	83		32	36 irritable	33
Kuwait							
Issa	88	88	83				
Qatar							
Dawood	93	93	60				
Central and South America							
Chile							
Fadda	83	75	88	43	17		
Montes	83	65	63	10			
Haiti							
Minehan	100	100	60				
Puerto Rico							
Rossello	93	79	66				
Trinidad and Tobago							
Anatol	3	82	73	24	26	18 irritable	
Kuruvilla	63	95	74	25	14	20 irritable/ 32 lethargy	
Venezuela							
WHO/V&B/00.23	72	100					

Table 6: *(continued)*

Country	Abdominal pain	Vomiting	Rectal bleeding or bloody stool	Diarrhoea	Constipation	Irritability / lethargy	Malnutrition
North America							
Canada							
Ein 1971	85	80	60	7			
Ein 1997	73	48	43				
Newman	64	80	72			24 lethargy	
Racette	63	90	54	20	32	5 lethargy	
Wansbrough		90	85				
USA							
Abbott	82	79	70				
Bruce	85	68	37	11			0
Ching	92	83	60				
Immordino	50	60	30	20	5		
Kerry	73	48	27				
Larsen	85	87	66	17			
Meier (Texas)	76	80	50				
Meier (Indiana)	88	86	52				
Rosenkrantz	58	64	36				
Schoo	69		43				
Skipper	66	69	43			22 lethargy	
Spain	74	85	54				
Swenson	88	80					
Thomas	54	56	65				
Wayne	94	91	66				
West	80	85	53			45 lethargy	

Table 6: *(continued)*

Country	Abdominal pain	Vomiting	Rectal bleeding or bloody stool	Diarrhoea	Constipation	Irritability / lethargy	Malnutrition
Europe							
Belgium							
Nobre	79	66	50	13	4		
Denmark							
Kvist		100	61				
Madsen	95	100	63				
Finland							
Myllya	83	83	66				
France							
Carcassonne	82	72	48				
Heloury	81	75	35				
Weisberber	80	60	44	6			
Germany							
Deindl	56	81	55				
Staatz	73	50	28	22		14 apathy	18
Von Hille	58	82	59				
Israel							
Eshel	>38	97	>29			>39 irritable	
Freund	52	92	56				
Italy							
Baracchini	40	20	14	3			
Bardini	90	85	93				
Marinaccio	72	58					
Nethrlands							
Reijnen (a)	85	79	34	27			
Stradmeijer	85	60	50				
Van Heek	74	82	50				
Norway							
Albrechtsen	82	79	43	39			
Nordshus	90	70	59				

Table 6: *(continued)*

Country	Abdominal pain	Vomiting	Rectal bleeding or bloody stool	Diarrhoea	Constipation	Irritability / lethargy	Malnutrition
Europe cont.							
Poland							
Osemlak	100	78	63				
Portugal							
Cruz Lopes	88	82	67				
Spain							
Lasardi Iradi	81	78	44			83irrit/9lethargy	
Gracia Romero	86	82	62				
Bautista	87	79	83				
BG de Aguere	90	77	41				
Sweden							
Gierup	91	63	16	6			
Silwer	63	59	43				
Switzerland							
Fanconi	82	93	72				
United Kingdom							
Dennison	75	70	52	11	72	24 irritable	
Given	57	86	59	9			
Hood	67	80	57				
Hutchinson	82	80	36	13			
Liu	89	89	50				
Man	87	84	61				
Pollet	89	97	45				
Potts			46				
Thomas			65				
Wilson-Storey	88	86	56				

Table 6: *(continued)*

Country	Abdominal pain	Vomiting	Rectal bleeding or bloody stool	Diarrhoea	Constipation	Irritability / lethargy	Malnutrition
Oceania							
Australia							
Auldist	84	92	61	13			
Beasley	84	91	53				
Mackay	93	95	46	14			
Simon	62	81	67				
Sparnon	81	74	44	8			
Tangi	82	83	51				
New Zealand							
Raudkivi	49	81	63	13	11	35 irritable	

Table 7: Presentation with specific combinations of symptoms and signs

Table 7.1: Classic triad: vomiting, rectal bleeding or bloody stool and abdominal pain

Country, author	% patients presenting with vomiting, rectal bleeding and abdominal pain
Africa	
Nigeria	
Adebamowo	15
Ugwu	33
South Africa	
Postma	41
Tunisia	
Mahfoudh	37
Asia	
Hong Kong, China	
Peh	14-20
India	
Rattan	50
Jain	65
Republic of Korea	
Kim	65
Malaysia	
Laidin	10
Taiwan, China	
Chung	36
Pang	82
Eastern Mediterranean	
Lebanon	
Bitar	50
Qatar	
Dawod	55
Central and South America	
Trinidad and Tobago	
Kuruvilla	14
Anatol	36
North America	
Canada	
Harrington	10
Newman	32
Racette	25
USA	
Bruce	21
Rosenkrantz	28
Thomas	75
Europe	
Denmark	
Madsen	41
Finland	
Myllyla	41
France	
Caracassone	27
Heloury	23
Germany	
Staatz	21

Table 7: *(continued)*

Country, author	% patients presenting with vomiting, rectal bleeding and abdominal pain
Europe (contd)	
Israel	
Freund	12
Italy	
Salvatonio	56
Poland	
Osemlak	-50
Spain	
Bautista	49
Gracia	46
Sweden	
Gierup	10
United Kingdom	
Dennison	>66
Hutchinson	12
Man	46
Pollet	38
Oceania	
Australia	
Sparnon	45
New Zealand	
Raudkivi	20

Table 7.2: Presentation with four symptoms and signs: abdominal pain, vomiting, bloody stool or rectal bleeding and abdominal mass

Country, author	% patients presenting with four symptoms or signs
Africa	
Nigeria	
Momoh	38<1yr, 31 >1yr
Elebute	45
Asia	
Taiwan, China	
Lee CT	26
Chung	17
Europe	
Finland	
Myllyla	20
Sweden	
Rostad	30
United Kingdom	
Dennison	>66
Oceania	
Australia	
Sparnon	17
Tangi	23

Table 7.3: Presentation with other combinations of symptoms and signs

Country, auhor	Combination of symptoms and signs % patients	
Ethiopia		
Gudeta	Abdominal or rectal mass	80
Nigeria		
Mangete	Abdominal pain, rectal bleeding, abdominal mass	11
Momoh	Rectal bleeding and abdominal or rectal mass	60<1yr, 69>1yr
Odita	Blood on rectal examination and tender abdomen	50
Ugwu	Abdominal and rectal mass, pain and rectal bleeding	70
Israel		
Eshel	Vomiting, rectal bleeding and abdominal mass	29
	Screaming attacks, vomiting and lethargy	38
Trinidad and Tobago		
Kuruvilla	Abdominal mass and blood on rectal examination	65

Clinical signs

Africa

The presence of a palpable abdominal mass was reported to be the most reliable clinical feature on examination (Table 8). In the 15 studies reporting this finding the incidence of abdominal mass on clinical examination was between 28% and 72%. A mass detected on rectal examination was observed in 3-64% of patients in nine studies. In contrast, only about 7% of patients presented with a prolapsed intussusceptum (Table 8). Four studies reported the confirmation of blood on rectal examination (range 22-57%). Non-specific features such as abdominal distension and tenderness were observed in some studies (Table 8). Although a number of studies commented on the presentation of patients in hypovolaemic shock, the incidence of this late and severe presentation was reported in only one study from Ethiopia, where it occurred in 60% of patients (Kedir et al., 1998). Fever was common and may have contributed to diagnostic difficulties (Table 8).

Asia

Blood was found on rectal examination in 50-82% of patients in studies reporting this finding. Abdominal distension was frequently reported (range 38-94% of patients), and an abdominal mass was present in 19-78% of patients. The finding of a rectal mass was a sensitive sign when present (range 10-45%). Although shock was present in 41% of patients in one study (Taneja et al., 1968), the incidence in other regions was not reported. Fever was recorded frequently (Table 8).

Eastern Mediterranean

The presence of an abdominal mass was commonly reported in patients presenting with intussusception (Table 8) throughout this region. In Qatar an abdominal mass was identified in two-thirds of patients (Dawod et al., 1992). An abdominal and/or rectal mass was identified in 66% of patients in Iran and in 57% of patients in Lebanon (Farpour et al., 1970; Bitar et al., 1969). In Iran, poor nutritional status and/or constipation were observed in one-third of patients (Farpour et al., 1970).

Central and South America

The detection of an abdominal mass was reported in 15-77% of patients (Table 8) in this region. Blood present on rectal examination was identified in 76% and 87% of patients in studies from Trinidad and Tobago (Anatol, 1985; Kuruvilla et al., 1988). A rectal mass was found in one-third of patients presenting in Haiti (Minehan et al., 1974). Fever was frequently observed at presentation (Table 8). The combination of an abdominal mass and blood on rectal examination was observed in 65% of patients in a study from Trinidad and Tobago (Kuruvilla et al., 1988).

North America

The presence of an abdominal mass was detected in 5-90% of patients in studies from North America (Table 8). The presence of a rectal mass was uncommon (range 2-20%) and transanal prolapse of the intussusceptum was rare. The importance of a rectal examination in the diagnosis of intussusception was highlighted: in 96% of cases, blood was detected on rectal examination, but only 72% had a history of rectal bleeding (Newman et al., 1987). However, a negative stool haeme test did not exclude the diagnosis of intussusception. Eight of 31 patients (26%) had a negative test for faecal blood on examination (Kupperman et al., 2000).

Europe

The presence of blood on rectal examination was the most consistent feature on clinical examination (range 44-79%). An abdominal mass was found on clinical examination in 7-72% of patients and this was considered to be an important clinical sign (Man et al., 1983). A rectal mass or prolapse was uncommon. Fever was observed in 2-35% of patients (Table 8). The combination of vomiting, an abdominal mass and rectal bleeding was reported in 29% of patients in Israel (Eshel et al., 1997).

Oceania

An abdominal mass was detected on clinical examination in 43-79% of patients with intussusception. Blood was detected on rectal examination in over half the patients (range 54-69%). A mass palpated on rectal examination was reported in under 20% of patients. Fever was recorded at presentation in some patients. A presentation with shock occurred in 12% and 3.5% of patients in two studies from Australia (Auldist, 1970; Tangi et al., 1991). Dehydration was reported in 17-45% of patients from five studies (Table 8).

Table 8: Percentages of patients presenting with specified clinical signs

Country, author	Abdominal mass	Rectal mass	Intestinal prolapse	Abdominal distension	Blood on rectal examination	Shock	Fever
Africa							
Ethiopia							
Gudeta	62	58					
Kedir	60	63				60	44
Nigeria							
Adebamowo	29	10		41	57		41
Mangete	30	3					
Momoh	65<1yr,79>1yr		5<1yr,14>1yr	41<1yr,7>1yr	22<1yr,10>1yr		
Ameh	56			65			
Odita	33		4		50		
Akamaguna	30						
Nmadu (b)	70		0	70			
Adejuyigbe	28			33			36
South Africa							
Davies	68		16				
Postma	66	23	3	42			
Mayell	72	26	4	36			
Zaire							
Badibanga	34	11		54			31
Zambia							
Munkonge	64						

Table 8: *(continued)*

Country, author	Abdominal mass	Rectal mass	Intestinal prolapse	Abdominal distension	Blood on rectal examination	Shock	Fever
Asia							
India							
Taneja (b)	41	29		94	71	41	41
Chatterjee	73	45					
Pandit	36	18					
Talwar	48			69			33
Rao	43	28		70			
Singh	19	10		38			12
Madhusudhana	78	23	0	50			
Yadav	38	32	2	76	82		
Taneja (a)		28		75	50		42
Rattan	61		6				
Jain	52		12	81			
Indonesia							
Lubis	49			56			28
Van Heek Rural	57			90			
Van Heek Urban	40			64			
Japan							
Kato	72						
Republic of Korea							
Suh	72				70		
Kim	40			25			44
Taiwan, China							
Lee MT	75						
Chung	29						42
Malaysia							
Laidin	45			44	60		31
Thailand							
Sutthiwan	45			69	82		

Table 8: *(continued)*

Country, author	Abdominal mass	Rectal mass	Intestinal prolapse	Abdominal distension	Blood on rectal examination	Shock	Fever
Eastern Mediterranean							
Lebanon							
Bitar	57		1				
Iran							
Farpour	66			62			33
Kuwait							
Issa	58						
Qatar							
Dawod	67						
Central and South America							
Chile							
Fadda	68			38			42
Montes	15			15			
Haiti							
Minehan	37		33				
Puerto Rico							
Rossello	52	14					
Venezuela							
WHO/V&B/00.23							
Trinidad and Tobago							
Anatol	67	15		16	76		58
Kuruvilla	77				87		51

Table 8: *(continued)*

Country, author	Abdominal mass	Rectal mass	Intestinal prolapse	Abdominal distension	Blood on rectal examination	Shock	Fever
North America							
Canada							
Ein 1971	65	5					
Ein 1997	22						
Racette	5			42	50		35
Wansbrough	84						
USA							
Abbott	61	20					
Bruce	48	2			15		
Ching	50						
Immordino	40			15	20		
Kerry	25			21			
Larsen	51			15			25
Meier (Texas)	32	4			26		12
Meier (Indiana)	30	8			72		16
Schoo	48						
Skipper	16						
Spain	51						
Swenson	90	5	2		72		35
Thomas	41			10			
Wayne	59						
West	80	2		85			

Table 8: *(continued)*

Country, author	Abdominal mass	Rectal mass	Intestinal prolapse	Abdominal distension	Blood on rectal examination	Shock	Fever
Europe							
Belgium							
Nobre	44	1	2	27			
Denmark							
Masden	73						64
Finland							
Myllya	51						
France							
Caracassonne	23						
Heloury	50						
Weisgerber	25						35
Germany							
Deindl	43		1	14	44		16
Israel							
Eshel	>29						
Freund	56						
Italy							
Bardini	49						
Netherlands							
Reijnen 1990a	67						
Stradmeijer	45			31			
Van Heek	39						
Norway					46		
Albrechtsen	29	11					
Poland							
Osemlak	51			61	79	58	54
Sweden							
Geirup	24						2
Silwer	46						
Switzerland							
Fanconi	72						

Table 8: *(continued)*

Country, author	Abdominal mass	Rectal mass	Intestinal prolapse	Abdominal distension	Blood on rectal examination	Shock	Fever
Europe cont.							
United Kingdom							
Dennison	68	6					
Given	72	10	1	8	70		13
Hood	67						
Hutchinson	50	6			46		17
Liu	74	3			65	6	
Man	70						16
Pollet	56			17	45		17
Wilson-Storey	63						24
Oceania							
Australia							
Auldist	78	14		23	69	12	
Beasley	79	13		23	63		35
Mackay	77						
Simon	43						
Sparnon	56			12	12		24
Tangi	72					3.5	
New Zealand							
Raudkivi	61	27			54		24

Table 9: Influence of interval between onset of symptoms and commencement of definitive treatment on incidence of intestinal resection and death

	Time between onset of symptoms and presentation / diagnosis (% patients)		% patients requiring resection who presented within 24 hours or >48 hours after the onset of symptoms		% of total deaths occurring in children presenting/diagnosed within <24 hours or >48 hours following the onset of symptoms	
Country, author	**<24 hours**	**>48 hours**	**<24 hours**	**>48 hours**	**<24 hours**	**>48 hours**
Africa						
Nigeria						
Mangete	39	25		100(>72hrs)	3.7	53
Adejuyigbe	5	54>4 days		63 (>4 days)	0	71 (>4 days)
Ugwu	20					
Udezue	10	80	0	45		
Meier	22	58				
Ethiopia						
Gudeta	21	52				100
Waldeyes	40	56				100
South Africa						
Isdale	53%W,17% B	33%W, 45%B	13(<48 hours)	60		
Postma	25	36				100
Mayell	40	41	11	32	20	67
Tunisia						
Saied	33	55	22	22	0	100
Zaire						
Badibanga	31	65				

Table 9: *(continued)*

	Time between onset of symptoms and presentation / diagnosis (% patients)		% patients requiring resection who presented within 24 hours or >48 hours after the onset of symptoms		% of total deaths occurring in children presenting/diagnosed within <24 hours or >48 hours following the onset of symptoms	
Country, author	**<24 hours**	**>48 hours**	**<24 hours**	**>48 hours**	**<24 hours**	**>48 hours**
Asia						
China						
Wang	74	6				
India						
Rao	14	46(>96hrs)			6	63 (>96hrs)
Yadav	8	22(>96hrs)			4	74
Taneja (b)	12	78				
Talwar	11	89(>24hrs)				
Rattan	24	76(>24hrs)				
Taneja (a)	0					
Jain		61(>72hrs)		100(>72hrs)		
Republic of Korea						
Suh	27					
Kim	62					
Malaysia						
Laidin	33					
Taiwan, China						
Lee CT	63	54				
Eastern Med.						
Iran						
Farpour	18					
Lebanon						
Bitar	63	26				

Table 9: *(continued)*

	Time between onset of symptoms and presentation / diagnosis (% patients)		% patients requiring resection who presented within 24 hours or >48 hours after the onset of symptoms		% of total deaths occurring in children presenting/diagnosed within <24 hours or >48 hours following the onset of symptoms	
Country, author	**<24 hours**	**>48 hours**	**<24 hours**	**>48 hours**	**<24 hours**	**>48 hours**
Central and South America						
Chile						
Fadda	52				3.2	
Haiti						
Minehan		66				
Venezuela						
WHO/V&B/00.23						
Trinidad and Tobago						
Kuruvilla			Average time to resection 19.6 hr	Average time to resection 45 hr		
North America						
Canada						
Ein 1971	70					
Newman	24	28				
Wansbrough	52	29			0	90
USA						
Ching	24	76(>24hrs)	0	46 (>24hrs)	0	0
Larsen	58					
Skipper	42	29				
Spain	37	63 (>24 hours)	0	23 (>24hrs)		
Thomas	61	23				
West	45	51				

Table 9: *(continued)*

	Time between onset of symptoms and presentation / diagnosis (% patients)		% patients requiring resection who presented within 24 hours or >48 hours after the onset of symptoms		% of total deaths occurring in children presenting/diagnosed within <24 hours or >48 hours following the onset of symptoms	
Country, author	**<24 hours**	**>48 hours**	**<24 hours**	**>48 hours**	**<24 hours**	**>48 hours**
Europe						
Belgium						
Nobre	54	24	2	38	0	0
Denmark						
Hansen	63				1	9 (> 24 hours)
France						
Carcassonne	67	19				
Heloury	40	7				
Germany						
Deindl	54		16	33		
Von Hille	58	16	8	52	1	31
Israel						
Eshel	66					
Italy						
Bardini	58	21				
Marinaccio	53			56 (>24 hrs)		
Netherlands						
Reijnen (b)		29				
Norway						
Nordshus	55	25				
Russian Federation/ Ukraine/former USSR						
Zubov	72					
Sweden						
Gierup	76					

Table 9: *(continued)*

	Time between onset of symptoms and presentation / diagnosis (% patients)		% patients requiring resection who presented within 24 hours or >48 hours after the onset of symptoms		% of total deaths occurring in children presenting/diagnosed within <24 hours or >48 hours following the onset of symptoms	
Country, author	**<24 hours**	**>48 hours**	**<24 hours**	**>48 hours**	**<24 hours**	**>48 hours**
Europe (contd)						
United Kingdom						
Dennison	63					
Given	88	9				
Hood	16					
Hutchinson	45					
Liu	82	5				
Pollet	55					
Thomas	47					
Yugoslavia						
Petrovic	52	29				
Oceania						
Australia						
Auldist	54		15	31	0	1
Tangi	59					

5.6 Site of intussusception

The site of the lead point of intussusception is most accurately determined at surgery when the bowel can be directly visualized. The increase in the proportion of patients treated non-surgically by enema reduction under X-ray or, particularly, ultrasound guidance, has meant that the definition of the lead point may be difficult or even impossible in some patients.

Africa

Twenty-five studies reported a description of the anatomical location of intussusception. In the majority of these studies the predominant site in infants under 1 year of age was ileo-colic or ileo-caecal (median 70%, range 12-95%). A higher incidence of caeco-colic and colo-colic intussusception was observed in children over 1 year of age than in infants under 1 year of age (69% and 22% respectively) (Momoh, 1987). In south-west Nigeria a high incidence of caeco-colic intussusception was observed, particularly in older children and adults (Adebamowo et al., 2000).

Asia

The predominant site of acute intussusception was ileo-caecal, ileo-ileo-caecal or ileo-colic in the 19 studies in which site was reported (range 32-100%). The next most common site was ileo-ileal or jejuno-ileal (range 0-43% of patients) followed by colo-colic (range 2-21%).

Eastern Mediterranean

Ileo-caecal or ileo-ileo-caecal intussusception was identified in over three-quarters of patients.

Central and South America

Ileo-caecal intussusception was detected in over three-quarters of infants.

North America

The predominant sites of acute intussusception in infancy were ileo-caecal and ileo-colic, reported in 61-98% of cases.

Europe

The presence of ileo-colic, ileo-caecal or ileo-ileo-colic intussusception was identified in the majority of patients with acute intussusception (range 53-96%).

Oceania

An ileo-colic or ileo-caecal site was identified in most infants with acute intussusception reported from Australia and New Zealand (Auldist, 1970; Raudkivi et al., 1981).

5.7 Investigations

The range of investigations used in the assessment of patients with suspected intussusception depends on the availability and affordability of tests and of expertise in interpreting the results. As a result there may be significant variation between hospitals in the same city, between rural and city hospitals, and between regions and countries.

This report reviews publications covering a period of 45 years, during which there have been significant developments in radiological techniques that have resulted in improved diagnostic accuracy and successful non-surgical management of intussusception. Over the past 10 years, abdominal ultrasound has been increasingly used for the diagnosis of suspected intussusception in infants and children. Intussusception has a characteristic sonographic appearance. This is described as an abdominal mass with a target sign, doughnut sign or concentric ring sign on tranverse section and a pseudokidney or sandwich sign on longitudinal section. The sensitivity of abdominal ultrasound in the diagnosis of intussusception in centres experienced in paediatric ultrasonography approaches 100%, while specificity ranges from 78 to 100% (Bhisitkul et al., 1992; Wright & Slater, 1996; Shanbhogue et al., 1994; Pracros et al., 1987; Verschelden et al., 1992; Woo et al., 1992; Wang & Lui, 1988; Harrington et al., 1998). In a recent prospective study, abdominal ultrasound had a negative predictive value of 98% for the diagnosis of intussusception (Harrington et al., 1998). Abdominal ultrasound also may assist in the definition of a pathological lead point (Navarro et al., 2000) or other intra-abdominal lesions unrelated to intussusception. In small studies, colour Doppler ultrasound has been reported to assist in the prediction of reducibility of intussusception by enema (Lim et al., 1994). The success of complete enema reduction and suspected recurrence can be assessed by means of ultrasound without additional exposure to radiation.

Despite the potential advantages of abdominal ultrasound in the diagnosis of acute intussusception, its use remains limited to centres with paediatric expertise in ultrasonography. The reasons are multifactoral. The study quality and interpretation are operator-dependent (Bissett & Kirks, 1988; Daneman & Alton, 1996). Although the sonographic features are suggestive of a diagnosis of intussusception they are not pathognomic and may occur in connection with other causes of bowel inflammation or oedema, haematoma, volvulus or even stool (Bissett & Kirks, 1988). In a crying child with moderate gaseous distension, or in a patient with small bowel obstruction, the examination may be technically difficult. To approach the diagnostic accuracy of ultrasound reported in published studies, specific training in paediatric ultrasound is required (Daneman & Alton, 1996; Verschelden et al., 1992). Even in centres where paediatric ultrasound expertise is available, some clinicians, given a typical clinical history, still prefer to proceed straight to enema diagnosis and reduction (Kirks, 1994).

Africa

The value of investigations such as a plain abdominal film, ultrasound, diagnostic barium enema, stool or haematological tests in diagnosing intussusception has been reported in only a limited number of studies. Plain abdominal X-ray revealed features consistent with intestinal obstruction in 32-67% of patients in the five studies in which this was reported (Odita et al., 1981; Akamaguna et al., 1985; Udezue et al., 1988; Postma et al., 1985; Davies et al., 1978; Mangete et al., 1994). The presence of a normal plain abdominal film in patients with surgically proven intussusception was reported in 13-27% of patients (Odita et al., 1981; Akamaguna et al., 1985; Postma et al., 1985).

Asia

Radiological features of intestinal obstruction on plain abdominal X-ray were observed in 44-100% of patients from studies reporting X-ray findings (n = 6). A normal plain abdominal film was observed in 34% of patients in a study from the Republic of Korea (Suh et al., 1968). The validity of the plain abdominal film in differentiating between intussusception and gastroenteritis was assessed in a study in Taiwan, China, which concentrated on the detection of nine specific radiological findings. If the diagnostic criteria for intussusception included the presence of three of the nine radiological findings, 95% of patients with intussusception would be positively identified and 74% of those with gastroenteritis would be excluded (Yang et al., 1995). Liquid contrast enema was performed in many centres in Asia to confirm the diagnosis prior to surgery or attempted hydrostatic or gas reduction. The use of ultrasound for the diagnosis of intussusception and for guiding gas/hydrostatic reduction was highly successful in those centres routinely using this technique (Rattan et al., 2000; Wang et al., 1988).

Eastern Mediterranean

The lack of sensitivity of the plain abdominal film in identifying abnormalities in patients with proven intussusception was highlighted in three studies. A normal abdominal X-ray was reported in 73% of cases in Qatar (Dawod et al., 1992) and 17% in Iran (Farpour et al., 1970). Diagnosis by liquid contrast enema was performed in most centres to establish the diagnosis of intussusception.

Central and South America

Plain abdominal X-ray had varied sensitivity in the two studies from Trinidad and Tobago. In one report, 94% of cases had a plain abdominal X-ray suggesting intestinal obstruction (Kuruvilla et al., 1988), whereas in another this was found in only 30% of patients (Anatol, 1985). A normal plain abdominal film was noted in 11% of patients with intussusception in Puerto Rico (Rossello et al., 1981). Liquid contrast enema was frequently performed to establish the diagnosis of intussusception in the countries of this region.

One-third of patients with intussusception in a study from Haiti were initially misdiagnosed. This was attributed to diagnostic difficulties caused by the frequency of other gastrointestinal diseases including infestation, dysentery and malnutrition, as well as the lack of a trained paediatric radiologist to perform barium enema studies (Minehan et al., 1974). The white cell count was elevated (>1000 cells/cu mm) in 55% of patients with intussusception in a hospital study from Puerto Rico (Rossello et al., 1981).

North America

In North America the diagnosis of intussusception was made by abdominal ultrasound, computerised tomography scan or air/liquid contrast enema in most centres. The value of a plain abdominal film in the diagnosis of intussusception has been the subject of some controversy. A plain abdominal X-ray was considered highly suggestive of the presence of intussusception if it demonstrated a soft tissue mass, evidence of bowel obstruction or a visible intussusceptum. A highly suggestive abdominal X-ray was an independent predictor of intussusception occurring in 80% of patients with enema-proven intussusception. However, a non-suggestive abdominal X-ray (normal bowel gas pattern and no signs of a mass or obstruction) was found in only 9% of patients with intussusception (Kupperman et al., 2000). A white cell count exceeding 20 000 cells/cu mm with a left shift was associated with gangrenous bowel at operation (Ching et al., 1970).

Europe

Despite improvements in the investigation and options for management strategies, delays still occur in the diagnosis of intussusception because of the non-specific nature of symptoms and signs in some patients (Silwer et al., 1967; Gierup et al., 1972; Nordshus et al., 1993). In a study from Donetsk only 23% of patients with intussusception were referred with the correct diagnosis (Zubov et al., 1975). In the United Kingdom, 69% of patients with intussusception were initially admitted with the wrong diagnosis (Wilson-Storey et al., 1988). In a recent survey of the patterns of management of acute intussusception outside tertiary centres in England, two-thirds of respondents indicated that they used abdominal ultrasound to confirm the diagnosis of intussusception, either alone (36%) or in combination with abdominal radiography (34%). Twenty per cent of respondents performed a liquid contrast enema alone or in conjunction with abdominal ultrasound (10%) (Calder et al., 2001).

Abdominal X-ray was diagnostic in 91% of patients in a study from Spain (Bautista et al., 1988). This contrasted with studies from Paris and Israel, where 50% and 21% of patients respectively, were reported to have a normal abdominal X-ray (Le Masne et al., 1999, Eshel et al., 1997). Ultrasound was reported to accurately diagnose intussusception in 42% of patients in a study from Italy (Marinaccio et al., 1997). The role of colonscopy in the diagnosis of intussusception was assessed in a study from the Russian Federation (Shchitinin et al., 1989).

Oceania

Intussusception may be difficult to diagnose in the first hours following onset. Sixty-nine percent of patients had been seen by a doctor on the day or days prior to a diagnosis of intussusception without the diagnosis being suspected (Auldist, 1970). Sixteen per cent of patients in this study did not have the correct diagnosis of intussusception until laparotomy was performed. This may reflect the coexistence of symptoms of an acute respiratory tract infection or gastroenteritis prior to presentation with intussusception, or may suggest that early symptoms and signs of intussusception are subtle and are frequently misinterpreted (Auldist, 1970). Abdominal ultrasound and gas or liquid contrast enema were the main diagnostic tests performed in children with suspected intussusception.

5.8 Treatment patterns

In many developing countries the treatment of intussusception is predominantly surgical. The facilities and technical expertise necessary to perform safe and effective enema reduction are frequently unavailable outside major city hospitals. The late presentation of a significant proportion of patients in developing countries may render them unsuitable for enema reduction because of the increased risk of perforation and sepsis, even if these facilities are available.

Africa

The treatment of acute intussusception in African countries is predominantly surgical. The resection rate was relatively high in most studies (36% in Postma et al., 1985; 38% in Nmadu, 1992b; 66% in Munkonge et al., 1983). There was a strong association between the duration of symptoms and the time of diagnosis and definitive surgery (Table 9). Infants who presented more than 48 hours after the onset of symptoms had a resection rate of 60%; for infants presenting less than 24 hours after the onset of symptoms the corresponding figure was 12.8% (Meier et al., 1996). Spontaneous reduction was reported in up to 11% of infants and 3% of children aged over 1 year in Nigeria (Momoh, 1987). However, spontaneous reduction was not commonly recognized in other studies. In seven studies, hydrostatic enema reduction was reported to have had a disappointing success rate in infants (Davies et al., 1978 (8%); Postma et al., 1985 (0%); Isdale et al., 1986 (10-17%); Badibanga et al., 1980 (40%); Odita et al., 1981 (13%); Akamaguna et al., 1985 (17%); Adejuyigbe et al., 1991 (3%)). The reason for the limited use of hydrostatic enema therapy in the studies reviewed is likely to be multifactorial. The combination of the lack of a 24-hour radiological service with the expertise necessary to perform this technique safely was noted as an important factor by some authors (Chapman, 1973). In addition the late presentation of many patients may make them unsuitable candidates for gas/hydrostatic enema reduction because of the increased risk of perforation and sepsis and the higher rate of failure (Ugwu et al., 2000; Udezue, 1998; Chapman, 1973; Adebamowo et al., 2000) (Table 9).

Asia

Although the majority of patients in Asia were treated surgically, in some countries (including China, Hong Kong, Taiwan, the Republic of Korea and Japan) gas or liquid contrast enema therapy has become the mainstay of therapy. The success rate of hydrostatic or air enema therapy varied widely between institutions (Sutthiwan et al., 1982 (100%); Laidin et al., 1992 (29%); Yadav, 1986 (0%)), which may reflect differing expertise in this technique. In 1986, Guo and co-workers described their experience of air-pressure enema reduction of intussusception in 6396 cases over a 13-year period at the Shanghai Children's Hospital. The success rate had improved from >80% in the 1960s to 95% in the 1980s with relatively few complications (e.g. colonic perforation, 0.14%) or deaths (0.03%). A clinical scoring system was developed to predict the safety of air enema reduction, making it possible to identify high-risk patients requiring primary surgical therapy (Guo et al., 1986).

As a result of the late presentation of patients described in studies, particularly from developing countries, surgical management remains an important primary treatment modality. In a recent study from India, 83% of patients presented 48 hours or more after the onset of symptoms and, of these patients, all were treated surgically (Rattan et al., 2000). The use of mini-laparoscopic reduction of intussusception in children was recently reported in a paper from Taiwan, China (Lai et al., 2000). It was performed on two children who had failed saline enema reduction of ileo-colic intussusception. This minimally invasive approach may have a role in the future surgical management of patients with uncomplicated intussusception who have failed enema reduction. Spontaneous reduction was reported infrequently (Rao et al., 1996 (4%); Madhusudhana Murty et al., 1975 (8%)).

Eastern Mediterranean

The success rate of gas/liquid contrast enema reduction varied widely. In Qatar the success rate of enema reduction was 53%, with an increased likelihood of failure if rectal bleeding had been present for more than 12 hours (Dawod et al., 1992). In Lebanon, hydrostatic enema reduction was successful in 60% of patients in whom this was attempted (Bitar et al., 1969). The resection rate ranged from 2 to 28% in the seven studies presenting results of surgical intervention.

Central and South America

Surgery was the mainstay of treatment in studies from Central and South America. Enema reduction was attempted in 21 of 94 patients with a 24% success rate in Trinidad and Tobago (Kuruvilla et al., 1988). In Puerto Rico, only 3 of the 23 cases undergoing barium enema therapy were successfully reduced (Rossello et al., 1981). In Chile, however, barium enema reduction was successful in 73% of patients and air reduction was successful in 100% (Montes et al., 2000). The resection rate ranged from 16% in Trinidad and Tobago to 43% in Brazil (Kuruvilla et al., 1988; Anatol, 1985; WHO/V&B/00.23, 2000). An association was observed between the duration of symptoms and the need for resection (Table 9). On average, patients requiring resection in Trinidad and Tobago presented 45 hours after the onset of symptoms; for patients requiring simple reduction alone the corresponding time was 19.6 hours (Kuruvilla et al., 1988).

North America

In most centres of North America, gas/hydrostatic enema reduction was the primary mode of therapy in uncomplicated intussusception. The rate of successful reduction with enema therapy varied between centres from 13% to 100% (Daneman et al., 1998; Kerry, 1971), although the success rate tended to be higher in more recent studies (Wayne et al., 1973). Despite the improvement in the success of hydrostatic reduction, surgery still plays an important role in patients with complicated intussusception, prolonged duration of symptoms, transanal prolapse of the intussusceptum or recurrent intussusception or in those in whom attempts at hydrostatic reduction have failed. There was a significant association between hospital size and the likelihood of a patient with intussusception receiving surgical treatment (Brattan et al., 2001). Children attending a large children's hospital had a reduced risk of surgery, shorter length of stay and incurred smaller costs than patients attending hospitals with small paediatric case-loads (Brattan et al., 2001).

A clear relationship between prolonged duration of symptoms and the need for intestinal resection was highlighted in studies from Rochester and Kansas City (Table 9). In these studies, no patients who were diagnosed within 24 hours of the onset of symptoms required intestinal resection. In contrast, patients who presented more than 24 hours after the onset of symptoms had significantly higher rates of resection, viz. 28% and 46% (Spain et al., 1984; Ching et al., 1970).

Europe

Before the 1980s, barium/air reduction tended to be performed in a select group of patients with a variable success rate (Pollet et al., 1980; Hutchinson et al., 1980; Given et al., 1979; Liu et al., 1986; Man et al., 1983; Wilson-Storey et al., 1988). In a study from France, hydrostatic enema reduction was attempted in 40% of cases but, in three-quarters of these patients, enema reduction failed and surgery was required (Heloury et al., 1988). In the Russian Federation, air enema treatment is routinely performed with a success rate of 17 to 82% in studies reporting on this therapy (Chepurnoi et al., 1996; Raponski et al., 1966; Zubov et al., 1975; Neikov et al., 1992 Antoshkina et al., 1990; Akzhigitov et al., 1976, 1978). In Sweden over 90% of patients underwent hydrostatic enema therapy with a success rate exceeding 70% (Carstensen et al., 1984; Gierup et al., 1972). In Spain and Portugal, hydrostatic enema reduction was commonly performed as primary therapy (71-98% of patients attempted) with a success rate ranging from 30% to 89% (Barrio Gomez de Aguere et al., 1987; Bautista et al., 1988; Cruz Lopes et al., 1992; Lesartes et al., 1990). In Israel, enema reduction was successful in 74% and 69% of patients in two studies (Eshel et al., 1997; Zamir et al., 1984). Barium enema therapy was significantly more effective than hydrostatic enema therapy and a second attempt at enema reduction in clinically stable patients was successful in six of the eight patients in whom this was carried out (Eshel et al., 1997). Despite the apparent success of hydrostatic reduction therapy, intestinal resection was still required in some patients (range 4-47%). Spontaneous reduction was reported in less than 10% of patients (Carcassonne et al., 1988; Hutchinson et al., 1980; Dennison et al., 1970).

Oceania

Gas or liquid contrast enema was generally performed to establish a diagnosis and to attempt reduction therapy. Primary operative management was still performed in patients with a long history, i.e. exceeding 48 hours, or features of abdominal distension, dehydration or severe toxaemia (15% of patients: Auldist, 1970).

5.9 Mortality

Death caused by acute idiopathic intussusception in infants and children is now uncommon in developed countries. In contrast, mortality associated with intussusception remains high in some developing countries. Patients from developing countries tend to present later, i.e. more than 24 hours after the onset of symptoms, and to have higher rates of surgical intervention, intestinal resection and death (Table 9). Hospital-based reports may potentially underestimate the "true" death rate associated with intussusception as these reports do not include deaths that occur outside the hospital or deaths that occur in patients in whom an alternate diagnosis was proposed and no autopsy was performed.

Africa

The mortality rate associated with intussusception in Africa was generally high (up to 54%) (Table 10). It was particularly so in patients with a long history of symptoms before the commencement of definitive therapy (Table 9). The majority of deaths were reported in patients who received therapy more than 48 hours after the onset of symptoms (Table 9). Some of these patients presented with hypovolaemic shock and died preoperatively (Adejuyigbe et al., 1991), while others were admitted with an alternative diagnosis and were subsequently found to have intussusception.

In contrast to clinical practice in other countries, the treatment of intussusception remains almost exclusively surgical in most countries of Africa. The lack of radiological facilities and expertise in some regions means that the diagnosis cannot be established prior to laparotomy and that gas/hydrostatic reduction is only performed in a few centres. In addition, some regions may not have access to paediatric surgical expertise and this may affect the timing of surgical intervention and outcome. The intestinal resection rates in patients presenting after more than 48 hours ranged from 60% to 100%; for patients presenting after less than 48 hours the corresponding value was 12.4% (Isdale et al., 1986) (Table 9). The mortality rate was higher in patients requiring intestinal resection than in those requiring reduction alone (El-Barbari et al., 1978). Early post-operative complications such as septicaemia, haemorrhage and abscess formation were more frequent in the late presenters (Postma et al., 1985). There are a number of reasons for late presentation and/or treatment. The clinical symptoms and signs of acute intussusception may be non-specific and can be mistaken for acute gastroenteritis or another benign non-surgical condition. Some patients may initially be conservatively managed in the belief that traditional remedies may be effective (Akamaguna et al., 1988). The lack of radiological facilities and paediatric surgical expertise may mean that diagnosis and treatment may be delayed or not even established prior to death.

Asia

Mortality documented in the reports from studies in Asia varied markedly between and within countries (range 0-58%) (Table 10), yet over time there has been a reduction in mortality in some regions. In New Delhi between 1961 and 1971 the mortality rate associated with intussusception was 58% (Taneja et al., 1968). From 1968 to 1978 it fell to 26%, and between 1993 and 1997 it fell to zero (WHO/V&B/00.23, 2000). Mortality was significantly higher (over ten times higher in most studies) in infants presenting 48 hours after the onset of symptoms than in infants presenting within 24 hours (Rao et al., 1996) (Table 9). Mortality and the

rate of major complications were higher in patients requiring resection than in those requiring simple surgical reduction (Rao et al., 1996) (Table 9). These data suggest that delay in the diagnosis and initiation of treatment of intussusception contributed significantly to the high morbidity and mortality observed in the studies in this region.

Eastern Mediterranean

No deaths were reported in the studies from Qatar (Table 10). A mortality rate of 10.7% was reported from Iran; for patients requiring intestinal resection the mortality rate was 16% (Farpour et al., 1970).

Central and South America

The mortality rate of infants with intussusception varied between hospitals (Table 10). The highest mortality rate of 53% was observed in a general hospital in a remote tropical area of Haiti where poverty and poor hygiene were endemic (Minehan et al. 1974). Delays in admission, diagnosis and treatment were thought to contribute to the frequency of compromised bowel, intestinal obstruction, dehydration, sepsis and subsequent mortality.

North America

While most studies in the last 20 years registered no mortality, the United States National Center for Health Statistics (Centers for Disease Control and Prevention, Atlanta) recorded a total of 323 intussusception-associated deaths in all ages during the period 1979–1997. This represents an overall rate of 4.4 deaths per 1 000 000 live births. The mortality rate was higher in males than in females and was also higher among Black infants than among White patients. There were regional differences in mortality rates, the highest rates being observed in the Mid-West. Several characteristics of mothers were linked to the mortality rate, including age less than 20 years, non-White race, unmarried status, an education level below grade 12, and tobacco use (Parasher et al., 2000). Mortality was significantly increased in patients who presented 24 hours or more after the onset of symptoms (Table 9).

Europe

Over the past 50 years there has been a marked reduction in mortality related to intussusception and its treatment in a number of centres in Europe (Table 10). In most centres the management of intussusception today is not generally associated with mortality.

Oceania

Acute idiopathic intussusception is only rarely associated with death in patients from this region (Table 10). When death does occur it tends to be in patients for whom there has been a delay in diagnosis (Table 9). Six deaths were reported in a cohort of 203 patients in Melbourne between 1962 and 1968. Four of the six had a disseminated cancer (Auldist, 1970).

Table 10: Mortality

Country, author	Date of data collection	% mortality
Africa		
Egypt		
El-Barbari	1973-76	8.8
Hadidi	1994-97	0
Ethiopia		
Waldeyes	1963-70	24
Gudeta	1977-86	27
Kedir	1990-97	54
Ghana		
Archampong	1965-88	13
	1987-88.1.1	5
Nigeria		
Mangete	1985-92	12
Elechi	1982-88	13
Odita	1974-80	25
Akamaguna	1974-82	20
Nmadu	1981-90	38
Adejuyigbe	1981-88	38
Archibong	1981-90	9
Adebamowo	1975-94	9
Momoh	1975-84	22 < 1yr; 7 > 1 yr
Niger		
Harouna	1989-90	55
South Africa		
Mayell	1961-70	3
Davies	1968-75	5
Postma	1985*	10 (early 7%)
Isdale	1986*	10-17
Tunisia		
Saied	1972*	44
Mahfoudh	1981-90	6
Zaire		
Badibanga	1964-78	15
Zambia		
Munkonge	1980-82	3.4
Asia		
Bangladesh		
WHO/V&B/00.23	2000*	0.7
Myanmar		
Thein-Hiang	1984-86	24
China		
Guo	1985-88	0.03
Wang	1985-87	0
India		
Rao	1968-78	-39 (6% presenting < 24hrs; 63% presenting >96 hours)
Singh	1976*	33
Madusudhana	1967-72	33
Yadav	1968-85	18
Taneja	1968*	58
Chatterjee	1960-66	44
Nakarni	1961-66	20-25
Pandit	1968-71	20
Talwar	1968-72	28
Gopi	1981-85	7.6

Table 10: *(continued)*

Country, author	Date of data collection	% mortality
Asia *(contd)*		
WHO/V&B/00.23	1968-78	26
	1993-7.1	0
Rattan	1990-2000	3
Jain	1990*	5
Indonesia		
Lubis	1987-88	26
van Heek	1990-95	Rural 20
	1990-95	Urban 3
Japan		
Kato	1965-68	3
Republic of Korea		
Suh	1964-68	1.6
Malaysia		
Laidin	1971-80	1.4
Taiwan, China		
Clarke	1955-64	1.8
Lee CT	1980-85	2.4
Lee MT	1963-72	5
Thailand		
Sutthiwan	1970-77	8
Viet Nam		
WHO/V&B/00.23	1997	9
	1999	0
Eastern Mediterranean		
Iran		
Farpour	1970*	10.7
Lebanon		
Bitar	1962-69	1.4
Qatar		
Dawod	1984-89	0
Central and South America		
Chile		
Fadda	1957-69	13.3
Haiti		
Minehan	1967-73	53
Puerto Rico		
Rossello	1969-78	0
Venezuela		
WHO/V&B/00.23	2000	0
Trinidad and Tobago		
Anatol	1976-82	11
Kuruvilla	1982-85	6.4
North America		
Canada		
Ein 1971	1959-68	0
Ein 1997	1985-90	0
Racette	1957-68	3.5
Wansbrough	1915-50	5.2
USA		
Abbott	1945-58	4
Bruce	<1970s	3.4
	>1970s	0
Ching	1949-70	0
Immordino	1964-74	0

Table 10: *(continued)*

Country, author	Date of data collection	% mortality
North Amercia *(contd)*		
Kerry	1960-70	0(paediatric)
Meier	1990*	0
Ponka	1928-64	6.5
Schoo	1953-69	5
Skipper	1977-88	1.3
Swenson	1944-60	0
Thomas	1921-31	47
	1931-46.A.1	18
	1939-46	6.6
	1951-66	0
Wayne	1942-71	2.3
West	1970-85	0
Europe		
Belgium		
Nobre	1967-81	0
Czech Republic		
Fiser	1950-54	4.8
	1955-66	0
Pohl	1966-71	1.3
Denmark		
Hansen	1936-45	5.7
	1946-55	3.8
	1956-65	0
Kvist	1976-86	0
Finland		
Kaltiala	1960-69	9
Myllya	1968-88	0
France		
Bachy	1969-81	0
Caracossonne	1976-86	0
Heloury	1982-86	0
Weisgerber	1976*	0
Germany		
Benz	>1966	0
Deindl	1970-88	1
Muhlbacher	1960-70	4
Von Hille	1959-73	0.06
Israel		
Eshel	1985-95	0
Italy		
Marinaccio	1988-94	0
Netherlands		
Reijnen	1968-88	0
van Heek	1990-95	0
Norway		
Albechtsen	1961-74	0
Portugal		
Cruz Lopes	1977-90	2.5
Russian Federation/ Ukraine/former USSR		
Akzhigitov	1062-74	0
Antoshkina	1974-87	0
Iakovlev	1975-85	3.5
Raponski	1952-64	6.4

Table 10: *(continued)*

Country, author	Date of data collection	% mortality
Europe *(contd)*		
Sitkovskii	1946-50	28
	1951-55	11.9
	1956-60	3.4
	1961-65	2.1
	1966-70	2.1
	1971-75	1.2
	1976-80	0.9
Sweden		
Bjarnason	1936-53	4.5
	1954-66	0
Carstensen	1976-86	0
Gierup	1952-70	0.7
Rostad	1968*	20
Switzerland		
Fanconi	1972-79	1.8
United Kingdom		
Dennison	1959-68	3.4
Given	1958-75	0
Hood	1957-65	2
Hutchinson	1969-78	1.4
Liu	1977-83	0
Man	1968-80	0
Pollet	1967-76	0
Oceania		
Australia		
Auldist	1962-68	3
Mackay	1982-84	0
Simon	1994	0
Sparnon	1979-84	1.6
Tangi	1976-88	1
New Zealand		
Raudkivi	1964-80	1

* Date of publication (date of data collection not reported).

Chapter 6: Discussion

Over the past two decades there has been a major effort to develop a safe and effective rotavirus vaccine in order to prevent the significant morbidity and mortality associated with rotavirus infection, particularly in developing countries. However, the first rotavirus vaccine to be licensed in the USA, the tetravalent rhesus-human ressortant rotavirus vaccine (RRV-TV; Rotashield®, Wyeth Lederle Vaccines, Philadelphia), has been withdrawn because of an association between receipt of the vaccine and the development of intussusception. This association has implications not only for the future development of other candidate rotavirus vaccines but also for the development of other oral vaccines.

This report describes the incidence, clinical presentation and management of acute intussusception in infants and children from 70 developing and developed countries. A global perspective of the problem of intussusception is thus presented which will aid the development of clinical trials of both rotavirus vaccines and oral vaccines.

Intussusception is the most common cause of acute intestinal obstruction in infants and young children. In developed countries the incidence of acute intussusception in infants and children is reported to be between 0.5 and 4.3 cases per 1000 live births or 0.66 to 1.2 cases per 1000 children under 1 year of age (Table 3). Accurate figures on the incidence of acute intussusception in infants and children are available for very few developing countries. In South America the incidence per 1000 children under 1 year of age is reported to range from 0.24 cases in Venezuela to 0.035 cases in Brazil. In Taiwan, China the incidence is similar to that in the USA and the United Kingdom (0.77 cases per 1000 live births), whereas studies from China suggest a significantly higher rate, over 6000 cases having been treated in a 13-year period at the Shanghai Children's Hospital. Unfortunately, the absence of demographic data in the latter example has not allowed an estimate of the incidence of intussusception to be made.

In Africa the number of cases of acute intussusception varies widely between hospitals from 60 cases per year in Cairo to 1 to 2 cases per year in centres in Ethiopia and Nigeria. Although an accurate estimate of the incidence of acute intussusception in children in Africa was not possible on basis of the available data, the figures provided some useful indications. In Nigeria, for example, data were combined from studies at nine centres during the same period to give an estimate of 72 cases of intussusception per year. However, these hospital-based studies are likely to reflect the minimum number of patients with acute intussusception as they only include those presenting to a major hospital in whom a positive diagnosis is established. The figures do not take into account any patients who die elsewhere than in these hospitals or those that may die while being treated for a different diagnosis.

The annual incidence of acute intussusception varied from year to year in many reports from both developing and developed countries. In most developed countries there has been no significant change in the pattern of incidence of acute intussusception in children over the past 20 years. However, in Aberdeen, Scotland, a decline in incidence was reported from 1950 to 1975, although no similar pattern was observed in neighbouring regions. There has also been a decline in the incidence of adult intussusception in some regions of Nigeria over the past 20 years, where the majority of adult episodes were reported in the caeco-caecal, caeco-colic or colo-colic region. A 31% decline in the absolute number of infants and children presenting with acute intussusception was also reported from 1975 to 1994, despite stable hospital admission rates and policies. The reasons postulated for this decline include the increasing Westernization of a diet of high-fibre roots rich in nitrosamines. However, the incidence of acute intussusception in infants has been reported to be increasing in China, Ghana, and Trinidad and Tobago. An explanation for this increase has not been determined. The underlying reason or reasons for these differences in incidence remain speculative, but they may relate to epidemics or to environmental factors that may influence dietary intake or the contamination of foods.

In almost all published studies the proportion of male patients was higher than that of female patients. The peak age at presentation was 4 to 8 months in most regions. A younger age at presentation was noted in infants developing intussusception following the administration of an oral rotavirus vaccine. The potential role of ethnic differences in determining the incidence and clinical manifestations of intussusception was addressed in nine studies. However, it is unclear whether the differences observed in some studies related to a genetic or ethnic predisposition, or whether they occurred as a result of confounding variables such as nutritional status, weaning practices, diet and environmental and social factors.

There are also conflicting data from developing and developed countries on the existence and importance of seasonal variability in the incidence of acute intussusception. In studies that reported a seasonal pattern in the presentation of intussusception the highest number of cases tended to occur in spring and summer. In some regions this corresponded to the peak rate of acute respiratory tract infections and/or gastroenteritis, while other regions reported no significant association.

The discussion on the etiology of intussusception is limited to information that directly relates to the clinical epidemiology of the condition in developing and developed countries. No etiological factor was identified in the majority of cases of acute intussusception in infants under 1 year of age (Table 5). In older children and adults, however, a pathological lead point was identified more frequently. Lead points may include tumour, vascular malformations and polyps. Mesenteric adenitis was reported as a lead point in a significant proportion of cases in some studies, although the underlying causes for the increased inflammatory response were not identified (Table 5).

The most common symptoms observed at presentation were the classic triad of abdominal pain, vomiting and rectal bleeding. However, the presence of all three symptoms was inconsistent, even in studies from the same region. Abdominal pain was reported slightly more often at presentation in patients from developed countries than in those from developing countries. The presence of an abdominal mass was consistently reported in most studies from developing and developed countries.

Abdominal distension was reported more frequently in studies from developing countries and may reflect the higher incidence of intestinal obstruction at presentation in these countries. Rectal bleeding on history or examination was identified as a significant predictor of intussusception. An altered stool pattern, involving either diarrhoea or constipation, was more frequently observed in developing than in developed countries. The presence of a rectal mass or prolapse occurred more commonly in patients from developing countries and possibly reflected the longer duration of symptoms in these countries.

The predominant sites for acute intussusception in infants under 1 year of age were ileo-caecal, ileo-colic or ileo-ileo-colic in almost all studies, irrespective of the country of origin. These sites were not generally associated with an obvious etiological factor although they may have been associated with mesenteric adenitis. Other sites, in particular caeco-colic or colo-colic sites, predominantly occurred in older children and adults, and were more commonly associated with an underlying cause including tumour or vascular malformations. Clinical symptoms and presentation were reported to vary between patients with intussusception at different sites. Acute presentations are more commonly associated with ileo-caecal or ileo-colic intussusception, while a more chronic onset and recurrent intussusception are more commonly associated with caeco-colic or colo-colic intussusception.

Despite improvements in the methods of investigation, delays still occur in the diagnosis of intussusception because of the non-specific nature of symptoms and signs in some patients. This remains a clinical challenge in both developing and developed countries. Plain abdominal X-ray can assist in the screening of patients with suspected intussusception, particularly if the examination for specific radiological features is included. Abdominal ultrasound has been increasingly used for diagnosis in many centres in developed countries. While these are useful screening tools, the diagnosis of acute intussusception is generally confirmed by gas/liquid contrast enema or at laparotomy.

The treatment of acute intussusception remains surgical in many developing countries. The reason for the limited use of gas/hydrostatic enema therapy in these countries is likely to be multifactorial. The lack of a 24-hour radiological service and the expertise necessary to safely perform this technique was noted as an important factor by some authors. In addition, the late presentation of many patients may make them unsuitable candidates for gas/hydrostatic enema reduction because of the increased risk of perforation and sepsis and the higher failure rate. Gas or liquid enema reduction therapy has become the primary treatment of choice in uncomplicated acute intussusception in specialized centres in developing countries, as it is in developed countries. This approach to reduction has been associated with decreased mortality and morbidity and with cost benefits associated with a reduction in the length of stay in hospital. Despite the success of enema reduction in many patients, surgery still provides an important treatment option in patients presenting with shock, complicated or recurrent intussusception, prolonged duration of symptoms, transanal prolapse of the intussusceptum, or failed enema reduction.

Mortality caused by acute intussusception in infants was uncommon in studies from developed countries. Historical studies show a consistent improvement in mortality rates over the past 30 years related to early and improved diagnosis and the transition to non-surgical hydrostatic reduction techniques. The management of the condition has become so streamlined in some centres that outpatient management has been advocated. Notwithstanding improved outcomes in most patients, however, intussusception-associated mortality was reported in 323 patients in the USA during the period 1979-1997.

Mortality directly related to intussusception and its treatment is disproportionately high in developing countries. Patients from developing countries tend to present later, i.e more than 24 hours after the onset of symptoms, and this is associated with a higher resection rate and mortality (Table 9). The reasons for this may include delay in diagnosis and lack of access to the facilities and technical expertise necessary for gas/liquid contrast enema reduction and to paediatric surgical expertise.

In conclusion, in developed countries the baseline incidence of intussusception is reported to be between 0.5 and 4.3 cases per 1000 live births. Although there are limited data on baseline incidence in developing countries, some countries are reporting very high incidences. It is unclear whether these marked differences are associated with the accuracy and reliability of diagnosis or whether infants in specific regions are at increased risk of acute intussusception as a result of ethnic, genetic, cultural, dietary or environmental factors. Infants in developing countries tend to present after a longer period of symptoms and a higher incidence of bowel obstruction, transanal prolapse of the intussusceptum and vascular compromise than infants in developed countries. Mortality caused by intussusception is uncommon in developed countries but is reported in up to 50% of cases in some developing countries. Further studies are necessary on the risk factors and etiology associated with intussusception and on the role of alternative diagnostic and treatment options, particularly in developing countries.

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Annex 1:
Intussusception search data sheet

Country of origin: _____

Year of publication: _____

Authors: _____

Journal citation: _____

Methodology

Type of study: (i) Prospective review ☐ (ii) Retrospective chart review ☐ (iii) Case series ☐
(iv) Case report ☐ (v) Trial ☐ (vi) Other ☐

Hospital/region: _____

Period of data collection: _____

Other: _____

Results

Number of patients reported:

Of patients presenting: (i) all ☐ (ii) select ☐

Baseline hospital admissions: (i) all paediatric ☐ (ii) surgical ☐ (iii) other ☐

Baseline referral population: _____

Incidence: _____

Change in incidence: _____

Seasonal variability: Yes ☐ No ☐
Summer ☐ Autumn ☐ Winter ☐ Spring ☐

Age: _____

Sex distribution: _____

Ethnicity: _____

Type	**% patients**
Ileo-colic/ileo-ileo-colic	_____
Ileo-ileal	_____
Caeco-colic	_____
Colo-colic	_____

Etiology	**% patients**
Idiopathic	_____
Mesenteric adenitis	_____
Other	_____

Symptoms:	**% patients**
Vomiting	
Abdominal pain	
Rectal bleeding	
Diarrhoea	
Irritability	
Lethargy	
Constipation	
Malnutrition	
Other	
Classic three symptoms	
Other combinations of symptoms	

Signs	**% patients**
Blood per rectum	
Abdominal mass	
Rectal mass	
Transanal prolapse of the intussusceptum	
Abdominal distension	
Fever	
Dehydration	
Shock	
Other	

Investigations	**% patients**
Abdominal radiograph	
Abdominal ultrasound	
Gas/liquid contrast enema	
Other	

Treatment	**% patients**
Gas/hydrostatic enema	
Surgery	
Resection rate	
Other	

Timing	**% patients**	**<24 hours**	**>48 hours**
From onset to diagnosis			
Patients requiring resection			
Mortality rate			
Outcome			
Mortality rate			
Complication rate			
Recurrence rate			

Other important factors raised in article: _____

The Department of Vaccines and Biologicals was established by the World Health Organization in 1998 to operate within the Cluster of Health Technologies and Pharmaceuticals. The Department's major goal is the achievement of a world in which all people at risk are protected against vaccine-preventable diseases.

Five groups implement its strategy, which starts with the establishment and maintenance of norms and standards, focusing on major vaccine and technology issues, and ends with implementation and guidance for immunization services. The work of the groups is outlined below.

The *Quality Assurance and Safety of Biologicals team* team ensures the quality and safety of vaccines and other biological medicines through the development and establishment of global norms and standards.

The *Initiative for Vaccine Research* and its three teams involved in viral, bacterial and parasitic diseases coordinate and facilitate research and development of new vaccines and immunization-related technologies.

The *Vaccine Assessment and Monitoring team* assesses strategies and activities for reducing morbidity and mortality caused by vaccine-preventable diseases.

The *Access to Technologies team* endeavours to reduce financial and technical barriers to the introduction of new and established vaccines and immunization-related technologies.

The *Expanded Programme on Immunization* develops policies and strategies for maximizing the use of vaccines of public health importance and their delivery. It supports the WHO regions and countries in acquiring the skills, competence and infrastructure needed for implementing these policies and strategies and for achieving disease control and/or elimination and eradication objectives.

Department of Vaccines and Biologicals
Health Technology and Pharmaceuticals
World Health Organization
CH-1211 Geneva 27
Switzerland
Fax: +41 22 791 4227
Email: vaccines@who.int
or visit our web site at: http://www.who.int/vaccines-documents

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