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ORIGINAL ARTICLE

# Epidemiology of Childhood Intussusception and Determinants of Recurrence and Operation: Analysis of National Health Insurance Data Between 1998 and 2007 in Taiwan

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**Background:** To study the epidemiology of childhood intussusception and risk factors of recurrence and operation based on a nationwide data.

**Methods:** Children with hospitalization due to intussusception (ICD9: 560.0) between 1998 and 2007 were identified from a national health insurance database. The incidence was calculated by age, sex, calendar year and month of admission. Recurrence and operation rates, duration and costs of hospitalization were analyzed.

**Results:** A total of 8217 intussusception-related hospitalizations were identified in 7541 children. The incidence of intussusception peaked between 3 and 36 months of age. Male -to-female incidence rate ratio increased from 1.31 in the first year to 2.52 in the ninth year of life. The overall recurrence and operation rates were 7.9% and 24.9%, respectively. In children less than 1 year old, the recurrence rate was 10.1%, which decreased to 5.3% in children over 3 years old. Multiple logistic regression analysis showed that children receiving operation had a significantly lower risk of recurrence with an odds ratio (95% confidence interval) of 0.31 (0.24–0.41) after controlling for age and sex. There are significantly more cases occurring during the warmer months between May and October compared to the cooler months between November and April.

**Conclusions:** There was a male predominance of intussusception with a dynamic male-to-female incidence rate ratio. Children under 1 year of age have the highest recurrence and operation rates. Seasonal variation of intussusception was suspected in Taiwan.

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## 1. Introduction

Intussusception is the most common intestinal obstruction among infants and young children.<sup>1</sup> Epidemiological studies of intussusception have been performed, either for surveillance of adverse effects of rotavirus vaccine or to provide baseline epidemiological data.<sup>2–7</sup> Recurrence of intussusception is possible after successful reduction, with an approximate rate of 8–10%.<sup>8–11</sup> Failure of nonsurgical reduction for intussusception may require surgical intervention.<sup>12–14</sup> However, the epidemiological features of intussusception recurrence and surgical reduction are not well understood.

Taiwan, an island country with approximately 23 million people, has a National Health Insurance (NHI) system that covers almost 99% of the population, and NHI health care databases contain sufficient information to provide national epidemiology data on a specific disease. In 2005, Ho et al<sup>3</sup> first described the epidemiology of intussusception in Taiwanese children based on NHI data collected between 1999 and 2001. However, the results and conclusions of this study were based on only 3 calendar years and may not be long enough for making an inference on the recurrence rate.

The objectives of this study were (1) to explore the epidemiological features of intussusception in Taiwanese children based on a longer period of NHI data (1998–2007), and (2) to determine the rates of surgical intervention and recurrence of intussusception and their risk factors.

## 2. Materials and Methods

### 2.1. Patients and enrollment criteria

Children with a diagnosis of intussusceptions, and who were hospitalized between January 1998 and December 2007, were identified from the NHI Research Database. From this database, we identified intussusception cases on the basis of the International Classification of Diseases, 9<sup>th</sup> Revision, Clinical Modification (ICD-9-CM) code for intussusception (560.0), listed as any one of the first three major diagnoses.

Due to regulations of the Personal Electronic Data Protection Law of Taiwan, the identification (ID) numbers of all persons and hospitals in this database were encrypted to be unrecognizable from the original ID numbers. The new ID numbers permitted us to analyze a patient's data while remaining blind to the patient's identity. Date of birth, admission date and sex information were included in the NHI data files. We sorted the new ID numbers and carefully checked patients' birth dates, admission dates and

discharge dates. If one person was re-admitted to the hospital within 3 days (inclusive) of the previous admission date, the new admission was considered as an early recurrence. Otherwise it was considered as a late recurrence. Length of hospitalization and hospital costs were also compared between the operation and nonoperation cases.

The initial onset of intussusception was identified by the first admission date of intussusception-related hospitalization for each case. The incidence of intussusception was calculated according to age, sex, calendar year and month of hospitalization. The yearly incidences of intussusception were calculated as the number of intussusception cases divided by the population size of children less than 15 years of age during each calendar year between 1998 and 2007.

### 2.2. Data of weather statistics

Weather statistics were obtained from the archives of Central Weather Bureau of Taiwan.<sup>15</sup> The monthly temperature was averaged across 25 weather stations that continuously collect meteorological data for the entire island of Taiwan to obtain an average monthly temperature. The total number of hospitalized cases in each month and the mean monthly temperatures were shown together.

### 2.3. Statistical analyses

The incidence rate was expressed as the number of intussusception cases per 100,000 person-years. Statistical data on the population size for each age group of males and females were obtained from National Statistics, Republic of China (Taiwan).<sup>16</sup> In addition to simple tabulation of demographic data, multiple logistic regression model were constructed for risk factors associated with recurrence or operation of intussusception, including age, sex, season (warmer or cooler), previous operation and recurrence. Data were analyzed using Microsoft Excel and SPSS software (version 16.0; SPSS Inc., Chicago, IL, USA).

### 2.4. Ethical approval

The Ethics Review Board of our institute approved the study protocol. Because this study represents an analysis of secondary data, no informed consent was necessary.

## 3. Results

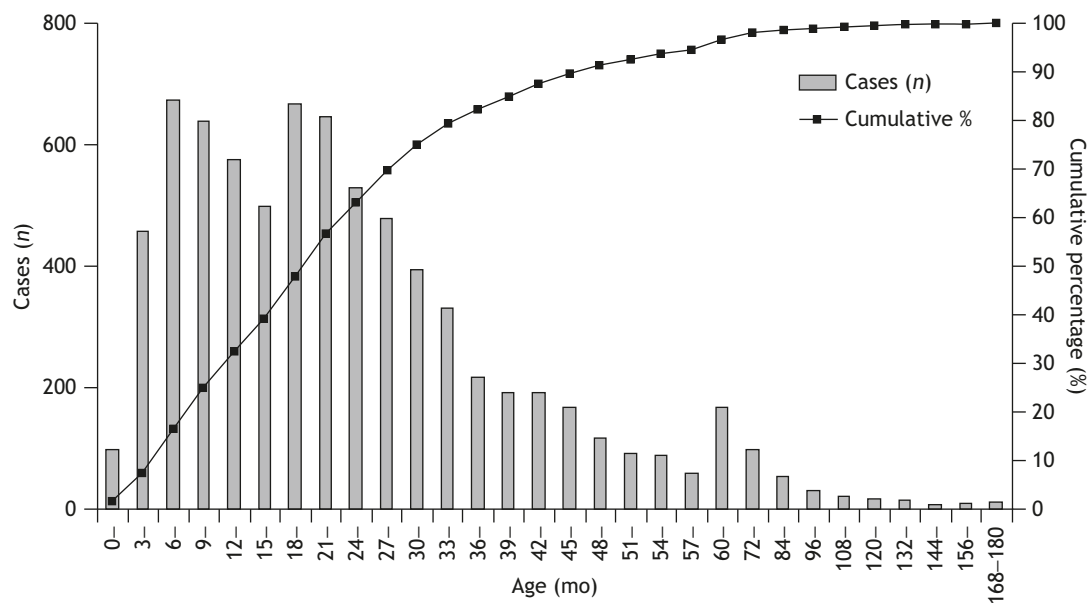
From the Taiwan NHI data collected between 1998 and 2007, a total of 8217 hospitalizations due to

intussusception were identified in 7541 children. Initial onset of intussusception before the first 3 months of life was relatively rare, and case numbers peaked between 3 and 36 months (Figure 1). The cumulative percentage of intussusception-related hospitalization was 24.8% in children less than 1-year-old, 56.5% in children less than 2 years old and 79.4% in children less than 3 years old (Figure 1).

The annual incidence rate of intussusception hospitalization varied slightly among different calendar years (Table 1). The incidence rate of intussusception was higher in the first 3 years of life (Table 1). Male children had a higher incidence

rate than female children (61.3 vs. 38.7 per 100,000 person-years, respectively), and the male-to-female incidence rate ratio showed an increasing trend from 1.31 in the first year of life to 2.52 in the ninth year of life (Figure 2). The mean age of the first episode of intussusception was 27.3 months of life in male children, and 24.9 months in females ( $p < 0.001$ ).

The mean number of monthly cases was significantly higher during the warmer months of May through October (mean  $\pm$  SD, 728  $\pm$  51) compared with that of the cooler months of November through April (mean  $\pm$  SD, 641  $\pm$  27) with a  $p$  value of 0.004 (Figure 3).

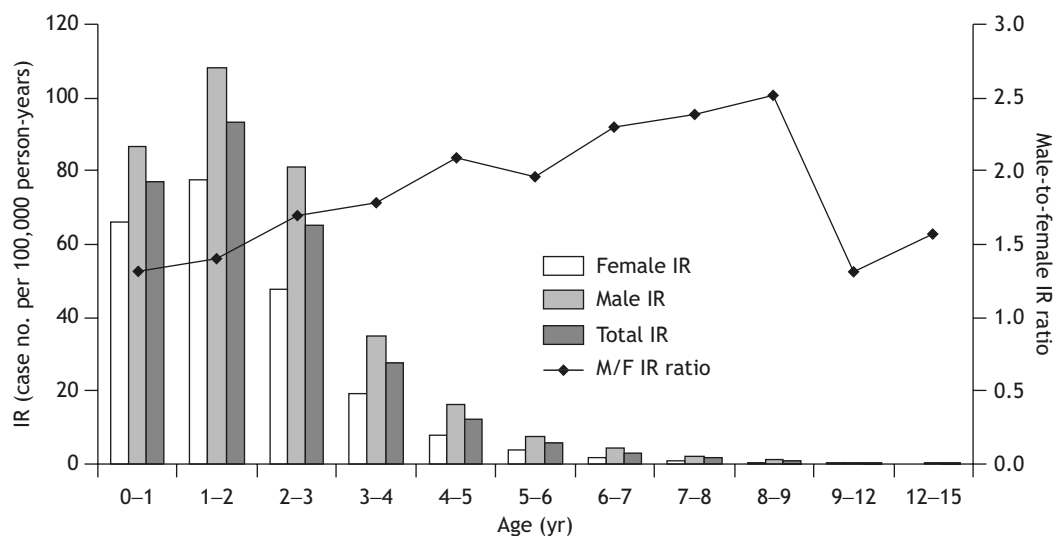


**Figure 1** Case numbers and cumulative percentage of intussusception in Taiwanese children less than 15 years of age between 1998 and 2007.

**Table 1** Incidence rate of intussusception by age groups in Taiwanese children less than 15 years of age from 1998 to 2007\*

Year	Annual incidence rate			Cumulative incidence rate		
	0-1	1-2	2-3	0-3	0-5	0-15
1998	75.9	72.7	41.2	62.5	37.3	14.2
1999	64.2	85.8	50.6	65.8	38.5	15.1
2000	66.8	88.1	83.3	79.0	45.7	18.6
2001	79.5	69.4	44.8	64.3	38.3	15.0
2002	84.4	102.9	65.5	83.3	50.1	18.1
2003	81.5	95.3	63.8	79.9	44.8	16.5
2004	85.0	114.1	69.5	89.0	49.4	17.7
2005	86.5	112.7	99.5	99.8	56.6	19.1
2006	74.8	106.4	61.9	80.7	46.3	15.5
2007	78.8	109.6	90.4	92.9	54.2	18.9
Total average <sup>†</sup>	77.0	93.5	65.0	78.3	45.5	16.8

\*Incidence rate was defined as the number of cases per 100,000 person-years in the same age group; <sup>†</sup>mean of all children in the specified age category.



**Figure 2** Incidence rates (case number per 100,000 person-years) of intussusception of the two sexes and the male-to-female incidence rate (IR) ratio in Taiwanese children less than 15 years of age between 1998 and 2007.

Among the 7541 children, 597 children (7.9%) were hospitalized more than once. In total, there were 676 episodes of recurrent hospitalization with 295 episodes (43.6%) recurring within 3 days of previous admission date and the remaining 381 episodes (56.4%) recurring later. However, the recurrence rate decreased as the age of initial onset increased (Table 2), and the recurrence rates were similar between male and female children (8.0% vs. 7.8%, respectively,  $p=0.826$  by Pearson  $\chi^2$  test). A total of 1878 children (24.9%) underwent surgical intervention. The rate of operation was significantly higher (34.3%) in cases with initial onset age of less than 1 year; the rates remained between 21% and 23% after the first year (Table 2). The 1878 cases receiving surgical intervention incurred a higher mean medical cost [New Taiwan (NT) \$51,411 or US\$1606] and a longer mean hospital stay (6.4 days) than those who did not require surgery (NT\$8716 or US\$272 US with a mean hospitalization of 2.6 days). The operation rate among cases with recurrence was significantly less than those without recurrence (Table 2). The mean age and sex ratio were not different between the operation and nonoperation groups.

#### 4. Discussion

The analysis of the national data of the last 10 years (1998–2007) showed that the incidence rate of intussusception was low for infants younger than 3 months old, then increased rapidly and peaked between 3 and 36 months of age (Figure 1). This finding is consistent with another nationwide epidemiological study in Switzerland.<sup>6</sup> The average yearly incidence rate of intussusception in Taiwanese children was 77.0

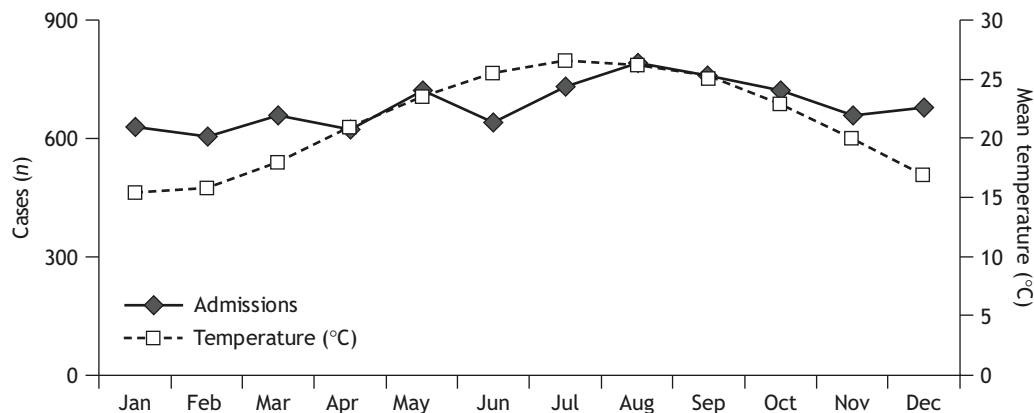
per 100,000 person-years in infants less than 1 year old (Table 1), very similar to other areas, such as Singapore with 60 per 100,000, Hong Kong with 78–100 per 100,000, the United States with 62 per 100,000 and Europe with 66–75 per 100,000.<sup>4–6,17,18</sup> Some previous studies cited a peak incidence of intussusception during the first year of life,<sup>4,6,7,19</sup> but a previous Taiwanese study favored the second year.<sup>3</sup> In Table 1, we found that both the first year and second year possibly have the highest incidence. Since the peak incidence of intussusception resembles a continuous plateau during months 3–36, as shown in Figure 1, therefore, it may not be easy to tell the exact age of peak incidence being in the first year or the second year of life. Table 1 also demonstrated a stable, although with some fluctuation, incidence of intussusception among different calendar years.

A predominance of intussusception among males has been noted in previous studies, with male-to-female ratios ranging from 1.3 to 2.0.<sup>2,4,18,20</sup> An interesting finding in this study was that the incidence rate ratio between two sexes was dynamic, increasing from 1.31 in children less than 1 year old to 2.52 in children 9 years old. The gradual increase of male-to-female incidence rate ratio by age may be related to the differential onset time between the two sexes, as the mean age of the initial onset of intussusception was significantly older in males than in females (27.3 months vs. 24.9 months, respectively,  $p<0.001$ ). The male-to-female incidence rate ratio decreased after 9 years of age, but the limited number of cases does not permit us to make any strong inference among older children or adolescents.

In this study, we found a total recurrence rate of 7.9%, which is consistent with the previously

**Table 2** Odds ratio (OR) and 95% confidence interval (CI) of multiple logistic regression model for risk factors associated with recurrence or operation of intussusception

	Cases ( <i>n</i> )	Recurrence		Operation	
		Cases <i>n</i> (%)	OR (95% CI)	Cases <i>n</i> (%)	OR (95% CI)
<b>Age (yr)</b>					
0–1	1869	200 (10.7)	1	641 (34.3)	1
1–2	2382	192 (8.1)	0.65 (0.53–0.80)	518 (21.7)	0.51 (0.45–0.59)
2–3	1736	122 (7.0)	0.55 (0.44–0.70)	363 (20.9)	0.48 (0.41–0.56)
≥3	1554	83 (5.3)	0.42 (0.32–0.55)	356 (22.9)	0.53 (0.46–0.62)
<b>Sex</b>					
Female	2823	221 (7.8)	1	675 (23.9)	1
Male	4718	376 (8.0)	1.08 (0.90–1.28)	1203 (25.5)	1.12 (1.01–1.26)
<b>Season</b>					
Cooler	3525	278 (7.9)	1	897 (25.4)	1
Warmer	4016	319 (7.9)	1.00 (0.84–1.18)	981 (24.4)	0.94 (0.85–1.05)
<b>Operation</b>					
No	5663	533 (9.4)	1		
Yes	1878	64 (3.4)	0.31 (0.24–0.41)		
<b>Recurrence</b>					
No	6944			1814 (26.1)	1
Yes	597			64 (10.7)	0.31 (0.24–0.41)
<b>Total</b>		<b>597 (7.9)</b>		<b>1878 (24.9)</b>	

**Figure 3** Monthly mean temperature and case numbers of intussusception hospitalizations in Taiwanese children less than 15 years of age between 1998 and 2007 were shown together.

published recurrence rates of 8–10%.<sup>5,8–11</sup> No sex difference in recurrence rate was noted; the incidence among males was 8.0% and among females was 7.8% ( $p=0.826$ ). In assessing the age of the recurrence, this study found that the percentage of recurrence decreased with increasing age of initial onset. In children less than 1 year old, the recurrence rate was 10.1%, which decreased to 5.3% in children over 3 years old (Table 2). Children receiving operation had a significantly lower risk of recurrence with an odds ratio (95% confidence interval) of 0.31 (0.24–0.41). This was reasonable because the leading

point may be removed and the intestines may be adhesive to surrounding tissues, and both factors reduced the recurrence of intussusception.

The operation rate was higher among cases with only one hospitalization (no recurrence) and remained constant regardless of the times of hospitalization among those cases with recurrences (Table 2). In this study, only 10 out of the 48 cases with more than three episodes of recurrences received an operation. This finding supports the opinion that each recurrence should be managed as though it were the first episode, and surgical reduction should be

reserved for cases with failure of hydrostatic reduction, positive peritoneal sign or suspected existence of pathological leading points.<sup>10,12</sup> As cases that received operations usually had longer hospital stays and incurred higher costs,<sup>3,21</sup> the risk and benefit of operation for recurrent intussusception should be fully explained to patients' families. The operation rate was also significantly higher in children less than 1 year old than those in the older ages (Table 2). However, the age and sex distribution did not differ between operation and nonoperation cases.

The seasonality of the occurrence of intussusception was controversial before; some studies reported no seasonal variations<sup>3,4,6,7,19,22</sup> while other studies favored seasonality.<sup>6,23</sup> In this study, we found the mean number of monthly cases being significantly higher during the warmer months than that in the cooler months ( $728 \pm 51$  vs.  $641 \pm 27$ , respectively,  $p=0.004$  as shown in Figure 3). We thought young children may have more outdoor activities in warmer seasons that possibly results in a higher chance to get viral infection and an increased tendency for intussusception.<sup>24</sup> However, the reasons of seasonal variation need further studies to clarify.

This study, using the NHI database, has several limitations. First, the data came from hospitalization records, so the intussusception cases that only presented to an emergency department or an outpatient clinic would not be included. This limitation may underestimate the occurrences of intussusception. However, as the yearly incidence rate of intussusception reported in current paper is similar to other countries, we think such estimation is acceptable. Second, the NHI reimbursement database is not originally collected for academic research, so we did not have all the clinical information, such as types of enema reduction, data of viral isolation or the pathology report for the surgical cases. Third, mortality due to intussusception could not be identified because case ID numbers were encrypted, preventing us from linking the mortality file to the national statistics. However, mortality from intussusception is generally rare and may be ignored. In spite of the limitations of the data used in this study, the NHI database still provides useful information for studying disease incidence on a national scale.

## 5. Conclusions

This nationwide epidemiological study documented the peak incidence rate of intussusception between 3 and 36 months of age and showed a dynamic change of male-to-female incidence rate ratio from 1.31 in the first year to 2.52 in the ninth year of life. The overall recurrence and operation rates were 7.9% and 24.9%, respectively, and both of them were

higher in those aged less than 1 year old. Finally, there were a greater number of cases occurring during the warmer months between May and October in Taiwan and the seasonal variation of intussusception was suspected.

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## References

1. Wyllie R. Ileus, adhesions, intussusception and closed-loop obstruction. In: Kliegman RM, Behrman RE, Jenson HB, Stanton BF, eds. *Nelson Textbook of Pediatrics*, 18th ed. Philadelphia, PA: Saunders, 2007:1568–71.
2. Archibong AE, Usoro IN, Ikpi E, Inyang A. Paediatric intussusception in Calabar, Nigeria. *East Afr Med J* 2001;78:19–21.
3. Ho WL, Yang TW, Chi WC, Chang HJ, Huang LM, Chang MH. Intussusception in Taiwanese children: analysis of incidence, length of hospitalization and hospital costs in different age groups. *J Formos Med Assoc* 2005;104:398–401.
4. Boudville IC, Phua KB, Quak SH, et al. The epidemiology of paediatric intussusception in Singapore: 1997 to 2004. *Ann Acad Med Singapore* 2006;35:674–9.
5. Huppertz HI, Soriano-Gabarro M, Grimprel E, et al. Intussusception among young children in Europe. *Pediatr Infect Dis J* 2006;25:S22–9.
6. Buettcher M, Baer G, Bonhoeffer J, Schaad UB, Heininger U. Three-year surveillance of intussusception in children in Switzerland. *Pediatrics* 2007;120:473–80.
7. Awasthi S, Agarwal GG, Mishra V, et al. Four-country surveillance of intestinal intussusception and diarrhoea in children. *J Paediatr Child Health* 2009;45:82–6.
8. Daneman A, Alton DJ, Lobo E, Gravett J, Kim P, Ein SH. Patterns of recurrence of intussusception in children: a 17-year review. *Pediatr Radiol* 1998;28:913–9.
9. Gonzalez-Spinola J, Del Pozo G, Tejedor D, Blanco A. Intussusception: the accuracy of ultrasound-guided saline enema and the usefulness of a delayed attempt at reduction. *J Pediatr Surg* 1999;34:1016–20.
10. Yang CM, Hsu HY, Tsao PN, Chang MH, Lin FY. Recurrence of intussusception in childhood. *Acta Paediatr Taiwan* 2001;42:158–61.
11. Ramachandran P, Gupta A, Vincent P, Sridharan S. Air enema for intussusception: is predicting the outcome important? *Pediatr Surg Int* 2008;24:311–3.
12. Pierro A, Donnell SC, Paraskevopoulou C, Carty H, Lloyd DA. Indications for laparotomy after hydrostatic reduction for intussusception. *J Pediatr Surg* 1993;28:1154–7.
13. Daneman A, Navarro O. Intussusception. Part 2: an update on the evolution of management. *Pediatr Radiol* 2004;34:97–108; quiz 87.

14. Chang YT, Lee JY, Wang JY, Chiou CS, Lin JY. Early laparoscopy for ileocolic intussusception with multiple recurrences in children. *Surg Endosc* 2009;23:2001–4.
15. Climate statistics: Monthly mean temperature. Central Weather Bureau, Taiwan. Available at: <http://www.cwb.gov.tw/> [Date accessed: November 1, 2009]
16. National Statistics, R.O.C.(Taiwan). Vital statistics: live births, birth rate, deaths and mortality. Available at: <http://www.stat.gov.tw/> [Date accessed: November 1, 2009]
17. Nelson EA, Tam JS, Glass RI, Parashar UD, Fok TF. Incidence of rotavirus diarrhea and intussusception in Hong Kong using standardized hospital discharge data. *Pediatr Infect Dis J* 2002;21:701–3.
18. Tate JE, Simonsen L, Viboud C, et al. Trends in intussusception hospitalizations among US infants, 1993–2004: implications for monitoring the safety of the new rotavirus vaccination program. *Pediatrics* 2008;121:e1125–32.
19. Chen YE, Beasley S, Grimwood K. Intussusception and rotavirus associated hospitalisation in New Zealand. *Arch Dis Child* 2005;90:1077–81.
20. Blanch AJ, Perel SB, Acworth JP. Paediatric intussusception: epidemiology and outcome. *Emerg Med Australas* 2007;19:45–50.
21. Dawod ST, Osundwa VM. Intussusception in children under 2 years of age in the State of Qatar: analysis of 67 cases. *Ann Trop Paediatr* 1992;12:121–6.
22. Parashar UD, Holman RC, Cummings KC, et al. Trends in intussusception-associated hospitalizations and deaths among US infants. *Pediatrics* 2000;106:1413–21.
23. Carneiro PM, Kisusi DM. Intussusception in children seen at Muhimbili National Hospital, Dar es Salaam. *East Afr Med J* 2004;81:439–42.
24. Hsu HY, Kao CL, Huang LM, et al. Viral etiology of intussusception in Taiwanese childhood. *Pediatr Infect Dis J* 1998;17:893–8.