Frequency of Rotavirus Infection among Vaccinated and Non-vaccinated Children with Diarrhea in Omdurman Pediatric Hospital, Sudan

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Abstract

Background: Rotavirus infection is the most common cause of severe diarrhea in young children and infants worldwide. Epidemiological knowledge concerning rotaviruses among infants and children is critical for the development of effective measures, including vaccines. **Method:** Cross-sectional study was conducted at Omdurman Pediatric Hospital, Sudan to investigate the frequency of rotavirus infection among vaccinated and non-vaccinated children and associated possible risk factors among children. The solid-phase sandwich enzyme-linked immunosorbent assay (ELISA) was used to detect rotavirus antigens. Structured questionnaire was used to gather socio-demographic data. **Result:** Out of 100 diarrheal cases, 21 were rotavirus-antigen positive (21%). Out of the 21 rotavirus positive subjects, 22% (11/50) were in non-vaccinated children and 20% (10/50) were in vaccinated children ($p > 0.05$). Second half of the first year of infancy showed highest incidence (34.8%) of rotavirus infection and the infection rate decreased with the increasing age ($p>0.05$). Children infected with rotaviruses were more likely to have vomiting (90.4%) ($P > 0.05$) and fairly low frequency of fever (71.4%) ($P > 0.05$). Out of the 21 rotavirus positive subjects,5 (26.3%) were breast-fed, 8 (34.8%) were both breast and bottle-fed, 5 (16.7%) were bottle-fed and 3 (10.7%) were neither breast nor bottle-fed ($p > 0.05$). Furthermore, the non-treated children revealed the highest percentage of rotavirus antigen (25%) compared to the antibiotic treated children (20.8 %). **Conclusion**: Rotavirus frequency was 21% (20% vaccinated and 22% non-vaccinated) among children less than 5 years. There is incidence of rotavirus infection among vaccinated children with Rotarix vaccine against rotavirus infection. The use of universal vaccine (multiple serotypes) is the most important preventive strategy.

Keywords: Rotavirus, Gastroenteritis, Diarrhea, Infants, Children

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Introduction

Rotavirus is a major cause of acute gastroenteritis in infants and young children worldwide. Rotaviruses belong to the Reoviridae family of non-enveloped double-stranded RNA containing viruses [1, 2]. The RNA is surrounded by a three layered icosahedral protein capsid that includes inner core, intermediate and outer layer. The genome of rotavirus comprises of 11 segements of double-stranded RNA, each coding for products that are either structural viral proteins (VP) or nonstructural proteins (NSP) [2, 3]. Rotavirus has been classified into seven major groups (A-G), based on antigenic epitopes on the internal structural protein VP6. Most human strains belong to group A, although groups B and C have occasionally been associated with human illness [4, 5].

Each year, rotavirus causes approximately 114 million episodes of gastroenteritis requiring only home care, 25 million clinic visits, 2.4 million hospitalizations and 610.000 deaths in children under five years of age [4].Typical symptoms include watery diarrhea, fever, abdominal pain, and vomiting, leading to dehydration and death [5]. Rotarix is a human, live attenuated rotavirus vaccine containing a rotavirus strain of G1 P-8 specificity [6]. Rotarix is indicated for the prevention of rotavirus gastroenteritis caused by G1 and non-G1 types (G3, G4, and G9) when administered orally as a 2-dose series (given at ages 2 and 4 months) in infants and children [6]. Each 1.5 mL dose of the vaccine contains not less than 10^6 CCID50 (cell culture infectious dose50%) of the RIX 4414 strain of human rotavirus of the G1P [8] type [6].

The aim of the current study is to determine the efficacy of rotavirus vaccine (Rotarix) in protection of infection and the possible major risk factors predisposing to rotavirus infection among children in Omdurman, Sudan.

Methods

This was a cross-sectional study conducted in Omdurman Pediatric Hospital, Sudan during the period of March-May 2012. Vaccinated and non-vaccinated children below five years of age suffering from diarrhea were included in the study. The parents of children were informed for the purpose of the study

before collection of the specimens, and verbal consent was taken. Personal and clinical data were obtained by direct interviewing questionnaire from the parents of the children. The stool specimens were collected in sterile stool containers. Then stools were stored at -20° C till processed. Enzyme-linked immunosorbent assay (ELISA) was used for rotavirus group A antigens using commercial diagnostic kits (ProSpecT, UK). The ProSpecT Rotavirus ELISA kit is used to assign stools as rotavirus positive or negative.

Statistics

Data were entered in the computer using SPSS and doubled checked before analysis. Significance of difference was determined using chi-square test. Statistical significance was set at P values < 0.05.

Results

Detection of rotavirus antigen among the diarrhea stools tested by antigen capture ELISA

A total of 100 fecal specimens from pediatric diarrheal patients were collected and examined by antigen capture ELISA for the presence of rotavirus antigen. Rotavirus was detected in 21/100 (21%) patients where 79/100 (79%) were rotavirus negative (Figure 1).

Effect of rotavirus vaccine on rotavirus infection

There was no significant difference ($p > 0.05$) between prevalence of rotavirus infection among vaccinated children 20% (10/50), and non-vaccinated children 22% (11/50) (Figure 2).

Distribution of rotavirus in pediatric diarrhea according to age groups

The highest positive cases for rotavirus infection were 34.8% among the age group 6-11 months (37.5% vaccinated and 62.5% non-vaccinated), 26.3% among the age group 0-5 months (80% vaccinated and 20% non-vaccinated), 20% among the age group 18-23 months (50% vaccinated and 50% non-vaccinated), 16.7% among the age group 12-17 months (20% vaccinated and 80% non-vaccinated), 10% among 24-29 months (100% vaccinated and 0% non-vaccinated), and 0% among 30-35 and 36-41 months with no significant difference ($P > 0.05$) between the age groups examined (Figure 3).

Distribution of rotavirus in childhood diarrhea according to gender

The results demonstrate that the highest positive cases of rotavirus infection were 23.6% among female (45.5% vaccinated and 55.5% non-vaccinated) and 19.3% among male (41.6% vaccinated and 58.4% non-vaccinated) with no significance difference ($P > 0.05$) between the gender types examined (Table 1).

Effect of type of feeding on rotavirus infection

Rotavirus positive cases revealed that there was no significant difference ($p > 0.05$) between incidence of rotavirus infection among breast feeding 26.3% (80% vaccinated and 20% non-vaccinated), breast and bottle feeding 34.8% (37.5% vaccinated and 62.5% non-vaccinated), bottle feeding 16.7% (20% vaccinated and 80% non-vaccinated) and others 10.7% (100% vaccinated and 0% non-vaccinated) (Table 2).

Clinical presentation of children with and without rotavirus among the diarrheal cases

The infantile diarrhea is usually accompanied by clinical symptoms like fever, vomiting, and abdominal pain. Rotavirus positive cases revealed that there were 71.4% with fever (60% vaccinated and 40% non-vaccinated), 90.4% with vomiting (42.1% vaccinated and 57.9% non-vaccinated) and 61.9% with abdominal pain (53.8% vaccinated and 46.2% non-vaccinated), however among rotavirus negative cases there were 79.7% with fever (46% vaccinated and 54 % non-vaccinated), 84.8% with vomiting (47% vaccinated and 53% non-vaccinated), and 73.4% with abdominal pain (44.8 % vaccinated and 55.2% non-vaccinated) (Table 3).

Effect of antibiotics on rotavirus infection

There was no significant difference ($p > 0.05$) between rotavirus infection among antibiotic treated cases 20.8% (50% vaccinated and 50% non-vaccinated) and those without treatment 25% (0% vaccinated and 100% non-vaccinated) (Table 4).

Table 1: The effect of gender of children on rotavirus infection

Gender	Subject examined	Rotavirus infection	
		No. positive	Percentage
Male	62	12	19.3%
Female	38	9	23.6%
Total	100	21	21%

Person Chi-square = 0.266; P value = 0.606 (P>0.05).

Table 2: The effect of type of feeding on rotavirus infection

Feeding	Subject examined	Rotavirus infection	
		No. positive	Percentage
Breast	19	5	26.3%
Breast and Bottle	23	8	34.8%
Bottle	30	5	16.7%
Others	28	3	10.7%
Total	100	21	21%

Person Chi-square =5.082; P value = 0.166 (P>0.05).

Table 3: Clinical presentation of children with and without rotavirus among the diarrheal cases

Clinical presentation	Number and percentage of samples			
	Rotavirus positive (n= 21)	**Positive (%)**	**Rotavirus negative (n=79)**	**Negative (%)**
Fever	15	71.4%	63	79.7%
Vomiting	19	90.4%	67	84.8%
Abdominal pain	13	61.9%	58	73.4%
Total	21	21%	79	79%

Person Chi-square = 0.669; P value = 0.413 (P>0.05), Person Chi-square = 0.0442; P value = 0.506 (P>0.05) and Person Chi-square = 1.069; P value = 0.301(P>0.05).

Table 4: The effect of antibiotics on rotavirus infection

Treatment status	Subject examined	Rotavirus infection	
		No. positive	Percent (%)
Received	96	20	20.8%
Not received	4	1	25%
Total	100	21	21%

Person Chi-square = 0.040; P value = 0.841 (P>0.05)

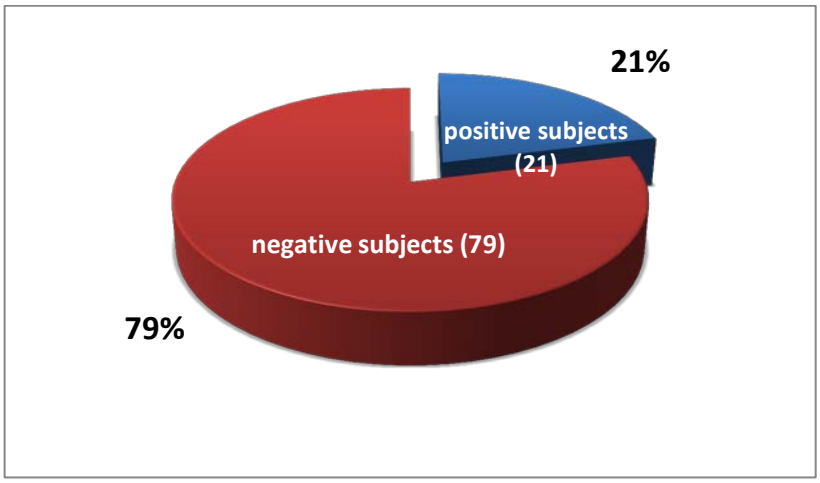

Figure1: **Detection of rotavirus antigen among the diarrhea stools.**

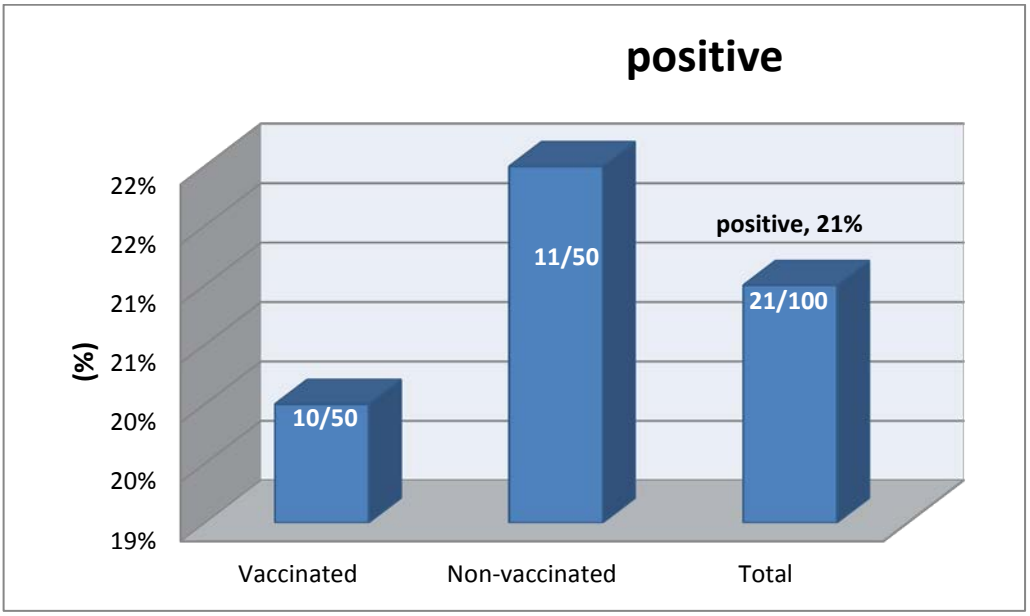

Figure 2: Effect of rotavirus vaccine on rotavirus infection.

Person Chi-square =3.623; P value =0.459 (P>0.05)

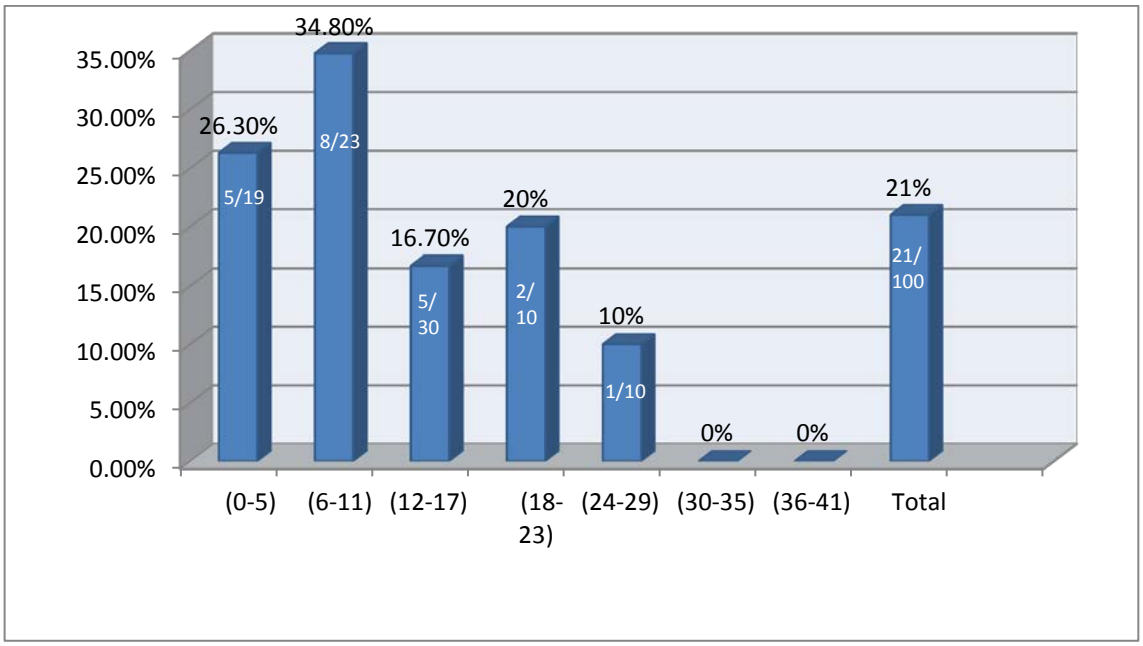

Figure 3: Distribution of rotavirus in pediatric diarrhea according to age groups.

Person Chi-square = 0.060; P value = 0.806 (P>0.05)

Discussions

Our results showed that rotavirus antigens were detected in 21 of 100 children (21%) (20% vaccinated and 22% non-vaccinated) less than 5 years of age, suffering from diarrhea by using antigen capture ELISA.

The detected frequency of infection appears to be less than the findings previously reported in Atlanta, Georgia (22%) [7], Africa, Asia and Latin America (25%) [8], Khartoum, Sudan (24.6%) [9], Omdurman, Sudan (25%) [10], Gaza, Palestine (28%) [11], Burkina Faso (33.8%) [12], Sudan (42%) [13] and the Middle East and North Africa (61%) [14]. However, rotavirus frequency obtained in this study appears to be higher than that reported in Khartoum (8.3%) [15], European Union (15%) [16] and Dar es salaam, Tanzania (18.1%) [17].

The low or high rates of rotavirus infections observed by different investigators could be attributed to several factors including, the study population, the diagnostic techniques used, the incidence rate of the

virus in different environments, the living conditions and standards of the study group, the season during which the study was conducted and the different subgroups and serotypes of rotaviruses prevalent in the area of the study [18].

Our study showed that rotavirus antigens were detected in non-vaccinated children 11 of 50 (22%) and 10 of 50 (20%) in vaccinated children, this could be due to circulating serotypes (that differ according to geographical distribution) which not included in the introduced Rotarix vaccine which includes just one serotype G1P[8] and also the storage and transportation may affect on efficacy of vaccine which highly sensitive to light.

The highest rate of infection were found with the age group 6-11 month (34.8%), 26.3% were 0-5 months of age, 20% were 18-23 month of age, 16.7% were 12-17 month of age, 10% were 24-29 month of age and 0% were 30-35 and 36-41 month of age. The findings of this study indicate there was a strong tendency of diarrhea to occur among children with age group 6-11 month, this could be explained by the declining immunity incurred through breast feeding [19] that protect the infants below 6 months of age and starting “oral phase” of the normal developmental milestones in children when babies put almost everything into mouth. Moreover, our study indicated that there was a trend of decreasing rates of rotavirus infection in the older children, this might partly be explained by the fact that older children acquired protective immunity during previous, probably subclinical, exposures to rotavirus and therefore become more resistant to infection with this agent [20].

This finding is consistent with the previous studies conducted in Burkina Faso [12], Dar es salaam, Tanzania [17] and Bangladesh [21] where the major burden of diseases due to rotavirus occurs in age group 6-11 month.

Slightly more males were admitted to the hospital due to diarrhea, rotavirus prevalence was higher in female cases 9 of 38 (23.6%) than in males 12 of 62 (19.3%), as reported in previous study conducted in the Gaza, Palestine [11], no reasonable explanation has yet been given for this distribution because there is no sexual physiological features.

In our study we found that rotavirus incidence occurred mostly among breast and bottle-fed 34.8% than breast-fed 26.3%, bottle-fed 16.7% and others 10.7% as reported in previous study conducted in Burkina Faso [12]. This high rates of rotaviral infections through breast and bottle-fed could be due to the declining of maternal antibodies which cause of low incidence of infection in breast-fed than breast

and bottle-fed. In addition, they could be due to the poor hygienic environment, where the bottle were possibly contaminated with children feces. The low rates of rotaviral infections through bottle-fed and other feeding could be due to acquired protective immunity during previous exposures to rotavirus.

In our study the clinical symptoms, fever, vomiting and abdominal pain were 71.4%, 90.4% and 61.9%, of infected children with rotavirus respectively. Vomiting is more common than other as in previous studies, Gaza, Palestine [11] and Dar es salaam, Tanzania [17], this might be due to high stimulation of enteric nervous system by NSP4 [22].

Out of the 21 positive samples, 20.8% were antibiotic treated cases, while the non- antibiotic treated cases were 25%, although there is no specific antiviral drug appropriate for treatment of rotavirus infections [23], this could be due to inappropriate use of antibiotics [24].

Conclusion

Our results indicate that gastroenteritis caused by rotavirus in the country is an important health problem, particularly among children less than 2 years of age. There is reported incidence of rotavirus infection among vaccinated children therefore serotyping and genotyping will help to select appropriate viral serotypes for proper vaccination.

The severe symptoms and fatal outcome from rotavirus diarrhea are due to dehydration (mainly vomiting), the acute loss of fluid and electrolytes; this can be treated with rehydration therapy and bad hygiene is major risk factor for rotavirus infection.

Ethics

This study was approved by the Medical Specialization Ethics Review Board, Sudan.

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