International Journal of Basic and Applied Virology 9(1): 14-22, 2020
ISSN 2222-1298

DOI: 10.5829/idosi.ijbav.2020.14.22

Rotavirus Outbreak Investigation in Kurmuk District, Assosa Zone of Benishangul-Gumuz Region, Feb, 2019

Dessalew Shitu

National Institute for Control and Eradication of Tsetse Fly and Trypanosomosis,
Kaliti Tsetse flies Mass Rearing and Irradiation Center, P.O. Box: 19917, Addis Ababa, Ethiopia

Abstract: Diarrheal diseases are one of the leading causes of illness and death in children less than 5 years of age, particularly those in low-income countries. Rotavirus alone caused an estimated death of 214806, 121009 and 6800 in children under 5 years of age globally, in Sub-Saharan Africa and Ethiopia respectively in 2013. On January 11, 2019, a suspected Rotavirus outbreak was reported to the zonal health department. We investigated the outbreak to identify associated risk factors and to implement control measures. *Method*: an unmatched case-control study was conducted from Jan 30-Feb 12, 2019 in Kurmuk woreda. Five stool samples were collected and tested using ELISA techniques for confirmation. A structured questionnaire was developed to collect cases and controls. A total of 144 study participants with 1:2 case to controls were selected. Data were analyzed using Epi-Info and the results were interpreted using Adjusted Odds ratio, P value <0.05 and 95% CI. Result: A total of 231 cases and 2 deaths were identified during the outbreak period with AR of 60.3/1000 population and CFR of 0.87%. All of the cases were under-five children and about 21.2% (49) cases were unvaccinated. In multivariate logistic regression, contact with cases (AOR: 8.58, 95%CI: 3.02-24.41, P: 0.0001) failure to practice handwashing at least three critical times (AOR: 2.94, CI: 1.12-7.69, P: 0.0281) were risk factors. On the other hand, vaccination (AOR: 0.29, 95%CI: 0.11-0.75, P: 0.0108) and history of similar illness (AOR: 0.18, 95%CI: 0.05-0.62, P: 0.0068) were found to be protective factors. Conclusion: A confirmed Rotavirus outbreak occurred. Contact with cases and failure to practice hand washing at least three critical times per day were associated with developing Rotavirus infection whereas being vaccinated and having previous history of Rotavirus infection were protective factors. Therefore, community health education and good hygiene practices combined with improved Rotavirus vaccination coverage would prevent future outbreak of the disease.

Key words: Rotavirus · Outbreak · Investigation · Kurmuk · Benishangul-Gumuz

INTRODUCTION

Diarrheal diseases are one of the leading causes of illness and death in children <5 years of age, particularly those in low-income countries and cause >500, 000 deaths per year globally [1-3]. Among these diarrheal diseases are Rotaviruses which are ubiquitous and infect almost every child globally by 3–5 years of age [4, 5]. In 2003, 114 million cases of rotavirus infection were reported in children <5 years of age globally, of which 24 million cases required outpatient visits and 2.3 million cases required hospitalization[6]. In 2013, rotaviruses were associated with an estimated 214, 806 and 121, 009 deaths in children <5 years of age globally and in Sub-Saharan Africa respectively [7]. Rotavirus infection was responsible for an estimated 128□500 deaths and 258 million episodes of diarrhea among children younger than 5 years throughout the world in 2016 an incidence of 0.42 cases per child-year, with 104□733 deaths occurring in sub-Saharan Africa [8].

Diarrhea is a leading killer of children in Ethiopia, causing approximately 14 percent of deaths in children less than five years of age [9]. Rotavirus, the most common cause of severe and fatal diarrhea in young children worldwide, took the lives of more than 6800 Ethiopian children under five in 2013 [7]. Ethiopia is one of top 10 countries with the greatest rotavirus burden worldwide and accounts for 3.2% percent of all rotavirus

Corresponding Author: Dessalew Shitu, National Institute for Control and Eradication of Tsetse Fly and Trypanosomosis, Kaliti Tsetse flies Mass Rearing and Irradiation Center, P.O. Box: 19917, Addis Ababa, Ethiopia.

deaths globally [7]. It is estimated that 28 percent of all under-five diarrheal disease hospitalizations in Ethiopia are caused by Rotavirus [10]. In Kurmuk district of Benishangul-Gumuz region, Rotavirus outbreak has been happening since February 2017 with 585 cases and CFR of 2.4% and in 2018 starting from 11th January with 444 cases and CFR of 0.2% [11].

Live attenuated oral vaccines against rotavirus were licensed for global use in 2006 and are used in more than 100 countries worldwide [12]. Although the introduction of vaccines has reduced the number of rotavirus-associated deaths, the effectiveness of licensed vaccines is suboptimal in low-income countries, in which, rotavirus gastroenteritis still results in >200, 000 deaths annually [7]. In another study, the vaccine use is estimated to have averted more than 28?000 deaths among children younger than 5 years and expanded use of the rotavirus vaccine, particularly in sub-Saharan Africa, could have prevented approximately 20% of all deaths attributable to diarrhea among children younger than 5 years [8]. The rotavirus vaccine was introduced in the Ethiopian national infant immunization program since November 2013 [13]. The introduction of Rotavirus vaccination in Ethiopia reduced the occurrence of the disease by 17% from 24% during the pre-vaccine period in 2011-2013 to 20% in post-vaccine periods of five consecutive years from 2014-2017 [14]. Regardless of this reduction and continued vaccination of the children, Rotavirus outbreaks are occurring in different parts of the country with the current report of outbreak in Kurmuk district of Benishangul-Gumuz region. The objective of this investigation was to confirm the existence of an outbreak, to describe it in place, person and time and to identify possible risk factors for the occurrence of this Rotavirus outbreak.

MATERIALS AND METHODS

Study Area and Period: The study was conducted from Jan 30/2019 to Feb 12/2019 in Kurmuk district of Benishangul-Gumuz regional state. The district is one of the 8 districts in Assosa zone consisting 14 rural and 2 urban kebeles with a total population of 23, 669. Of the total district population, 12, 035(50.8%) were males. Majority 20, 988 (88.7%) population live in rural area. Children under five age constituted 3829 (16.2%) of total district population. The district is bordered by Sherkole district in the North, Homosha district in the East, Assosa district in the South and North Sudan in the West. The district has lowland agro-ecological zone with total surface area coverage of 1437.7 Sq.Km and annual average rain fall ranges from 700ml-1000ml and temperature (26°C-35°C). The district has one functional health center and 11 health posts.

Study Design: Unmatched case control study design supported by descriptive study was employed to investigate the Rotavirus outbreak in Kurmuk district.

Study Population: All under-five children living in the outbreak affected kebeles of Kurmuk district, Benishangul-Gumuz regional state.

Sampling Technique and Sample Size: A simple random sampling technique was used to select respondents for this case- control study. A line listed cases were selected randomly and controls neighboring with cases were also selected. When there were more than two eligible neighbor controls for a case, lottery method was used to take the first two. Accordingly with a ratio of one case to two controls, a total 144 respondents were selected. To determine sample size an OR of 2.9 and exposure of 35% in controls and 61% in cases were used from previous study [15] with 95% CL and 80% power.

Data Collection Method: A structured questionnaire was used to interview the guardians of cases and controls. By using the line list and health extension workers, we went door to door to interview parents or guardians of the study participants. Information regarding demographic characteristics, clinical history and risk factors were collected. In addition to this, documents regarding previous outbreaks were assessed and discussion about the overall outbreak situation was conducted with regional, zonal and district Public Health Emergency management (PHEM) officers.

Laboratory Method: A total of five stool samples were collected from children with diarrhea and vomiting. The collected samples were transported to National Polio and Measles laboratory at Ethiopian Public Health Institute (EPHI) and Enzyme-linked Immunosorbent Assay (ELISA) technique was used to confirm the presence of Rotavirus antigen in stool samples.

Statistical Data Analysis: The data was collected, entered, edited and analyzed using Epi-Info version 7.2.1.0 software. Descriptive statistics from line listed cases was produced using Microsoft excel 2013. Bivariate and multivariate logistic regressions analyses were applied to

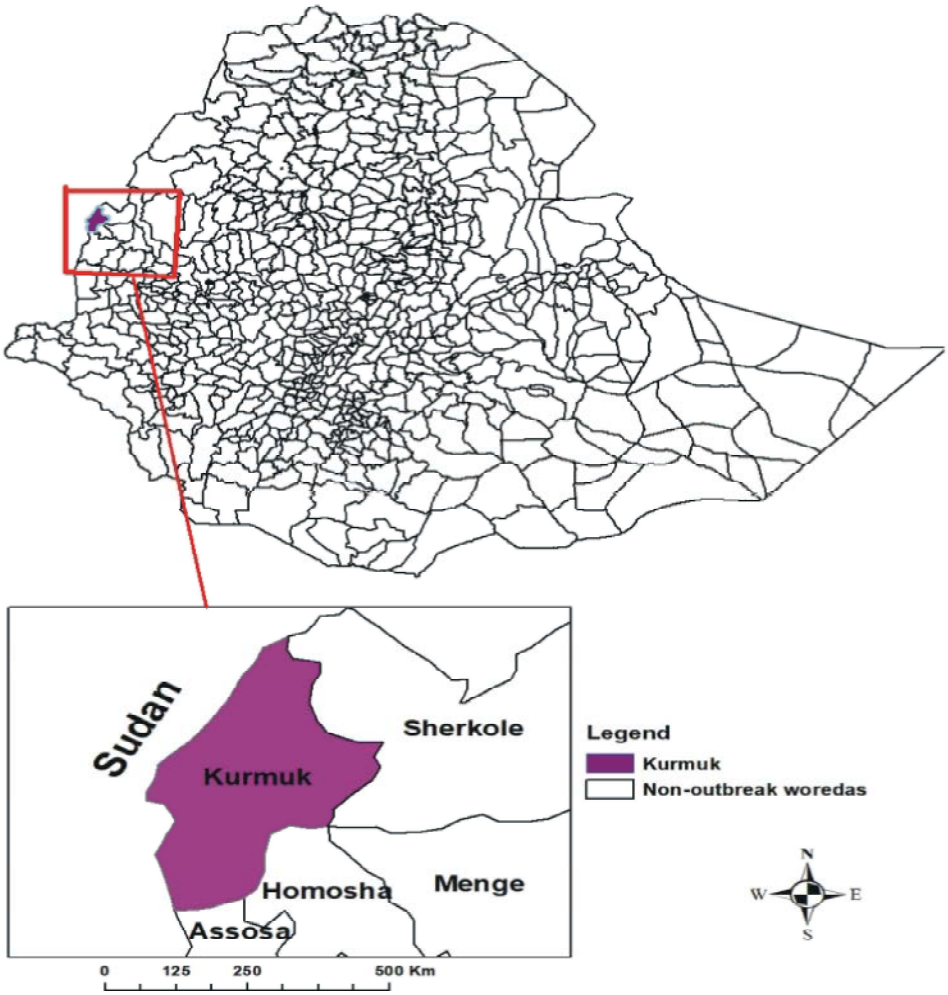

Fig. 1: Administrative map of BGR, Assosa zone and Kurmuk district

determine possible risk factors for an outbreak. Factors with P value <= 0.05 in bivariate analysis and biologically plausible were included in multivariate logistic regression and the result was interpreted using Adjusted Odds ratio, P value <0.05 and 95% confidence interval. Results for both descriptive and analytic statistics were displayed using tables and graphs. Geographical maps used in this document were produced by using ArcMap 10.4.1.

Case Definitions:

- Suspected case: Any child under five years of age with sudden onset of diarrhea with vomiting, two or more episodes within 24 hours, from Dec 22, 2018 to Feb 9, 2019 and residence of Kurmuk Woreda.
- Confirmed case: A suspected case in whose stool the presence of Rotavirus is demonstrated by means of an ELISA.
- Controls: Any child under five years of age without diarrhea and vomiting and resident of Kurmuk Woreda within period of Dec 22, 2018 to Feb 9, 2019.

Ethical Issues: A formal letter was delivered to Benishangul-Gumuz regional PHEM department from EPHI and then Regional PHEM in turn wrote a formal letter to Kurmuk district health office for the outbreak to be investigated. Written informed consent was also obtained from study participants.

RESULT

Descriptive Epidemiology: A total of 231 Rotavirus cases with 10(4.33%) hospitalization were reported in Kurmuk district from Dec. 22nd 2018 up to Feb 9th 2019 in children under the age of 5 years. The overall attack rate of the outbreak was 60.3 per 1000 population. Two deaths were

reported from the districts of two different kebeles with overall CFR of 0.87%. The index case was 11 months old male child from Dull-Shitallo Kebele reported on 22nd of Dec 2018 from the Health post. All (100%) of cases reported had watery diarrhea, 93(40.26%) vomiting and 53(22.94%) had fever. About 182(79%) of cases were vaccinated for Rotavirus and the administrative vaccination coverage of woreda was 86% as of December 2018.

All of the samples collected were tested by using ELISA technique and all of them were positive for Rotavirus antigen. The remaining cases were linked epidemiologically. From the total of 29 Expanded Program on Immunization (EPI) refrigerators in woreda, only 16 refrigerators were functional.

Description by Person: From the total reported Rotavirus cases, 131(56.7%) of them were males with the mean age of 17.33 months (SD=11.87) and 117(50.6%) were in the age group of 12-35 months (Table 1).

Males were more affected than females with an attack rate of 67.3 cases per 1000 population. Children under the age of one year were more affected with AR of 121.2 cases per 1000 population and CFR of 2.3% (Table 3).

Description by Place: The Rotavirus cases were reported from 15 kebeles out of 16 kebeles found in Kurmuk Woreda. Among the total cases, 46 (19.91%) and 37(16.02%) were reported from Dull-Shitallo and B/Jiblla Kebeles respectively (Fig. 2).

Table 1: Distribution of Rotavirus cases by sex and age group in Kurmuk district, 2019

Variable	Frequency	Percent
Sex		
Male	131	56.7
Female	100	43.3
Total	231	100.0
Age group (Months)		
<12	88	38.1
12-35	117	50.6
36-59	26	11.3
Total	231	100.0

Table 3: AR/1000 and CFR by sex and age group in Kurmuk district, BGR, Ethiopia, 2019

Variable	Popn. at risk	Cases	Deaths	AR/1000	CFR
Sex					
Male	1947	131	1	67.3	0.76%
Female	1882	100	1	53.1	1%
Age group (Months)					
<12	726	88	2	121.2	2.3%
12-35	1504	117	0	77.8	0
36-59	1599	26	0	16.3	0
Total	3829	231	2	60.3	0.87%

Description by Time: As shown in the Fig. 3, intervention was started lately because of delayed report from health facilities to the district health office. Health facilities continued managing patients as usual like other diarrheal diseases for more than two weeks after the first case with watery diarrhea and vomiting had visited health post at Dull-Shitallo Kebele on 22 Dec 2018.

But when the cases were increasing from day after day, they started suspecting Rotavirus outbreak and informed the district health office. Accordingly the district PHEM officer informed the zonal health department and zonal health department to the regional PHEM department on 11th Jan 2019. It was after this the zonal and regional PHEM departments jointly deployed Rapid Response Team (RRT) to the suspected Rotavirus outbreak area. The outbreak continued for six weeks and the highest number of cases were recorded on 13-01-2019, the date that intervention started. This increase of new cases was related with community mobilization activities and enhancing surveillance.

Public Health Intervention: Cases were managed at health post and health centre levels with ORS, Zinc and supportive treatment. There was shortage of medical supplies initially but later on supplies were sent from the region, zone and also the district purchased some supplies from Pharmaceutical Supply Agency. The main challenges were shortage of beds for admission and treatment.

Surveillance was enhanced with house to house active case search, active case search on facility registers, provision of case definition and orientation, contact tracing and follow up, institution of daily reporting from facilities and community including zero reports. Social mobilization and health education was undertaken in the affected kebeles through the Health Development Agents (HDAs) and one to five community networking. Health education on the signs and symptoms, mode of transmission and on the need to seek health care was provided through meetings at school, religious institutions and market places.

Analytical Epidemiology: A total of 144 study participants were include in this case control study with 48 cases and 96 controls. Majority of study participants both in cases (56.25%) and controls (58.33%) were females with mean age of 27.46±15.37 and 27.88 ±15.39 months respectively.

Both bivariate and multivariate logistic regression analyses were conducted to determine risk factors for the outbreak of the disease. All factors which were

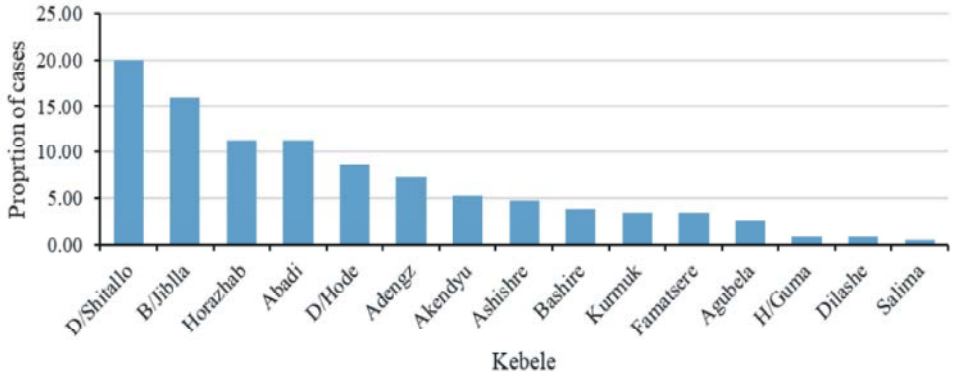

Fig. 2: Proportion of Rotavirus cases reported by Kebeles during outbreak, Kurmuk, 2019

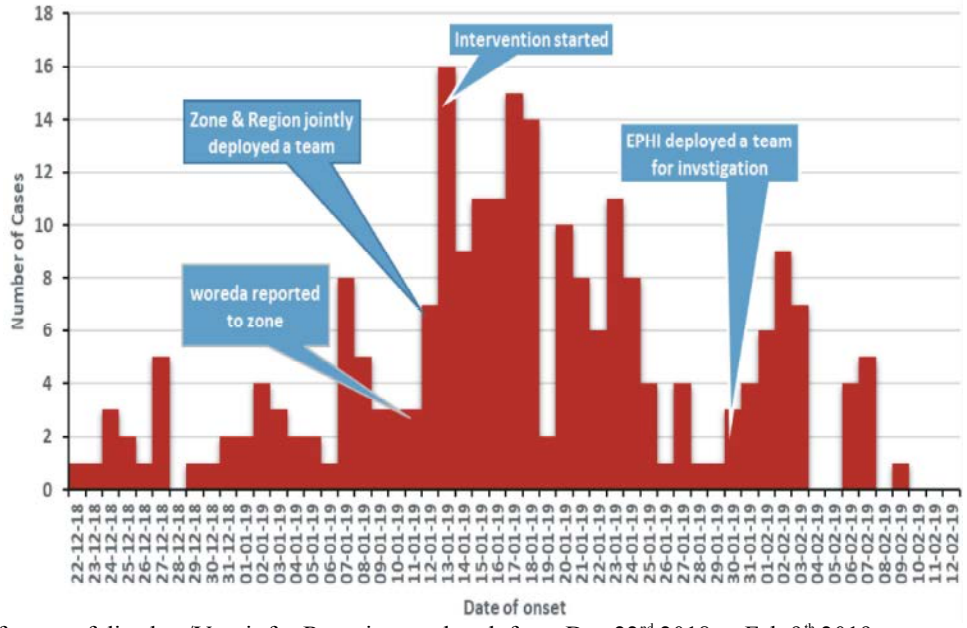

Fig. 3: Date of onset of diarrhea/Vomit for Rotavirus outbreak from Dec 22nd 2018 to Feb 9th 2019

Table 5: Bivariate and multivariate logistic regression for Rotavirus outbreak in Kurmuk district, BGR, 2019.

Variable	Category	Case	Control	Bivariate analysis COR (95% CI)	P-v	Multivariate analysis AOR (95% CI)
Contact with sick	Yes	33(68.8%)	36(37.5%)	3.67(1.75-7.66)	0.0006	8.58(3.02-24.41)
	No	15(31.3%)	60(62.5%)			
Vaccinated	Yes	23(47.9%)	72(75%)	0.31(0.15-0.64)	0.0015	0.29(0.11-0.75)
	No	25(52.1%)	24(25%)			
History of similar illnesses last year	Yes	5(10.4%)	36(37.5%)	0.19(0.07-0.53)	0.0015	0.18(0.05-0.62)
	No	43(89.6%)	60(62.5%)			
Traditional gold mining	Yes	40(83.3%)	51(53.1%)	4.41(1.87-10.41)	0.0007	6.34(2.15-18.71)
	No	8(16.7%)	45(46.9%)			
Exclusive breast feeding	Yes	25(52.1%)	68(70.8%)	0.45(0.22-0.92)	0.028	0.59(0.22-1.54)
	No	23(47.9%)	28(29.2%)			
Know advantage of vaccination	Yes	37(77.1%)	86(89.6%)	0.39(0.15-1.00)	0.05	0.33(0.09-1.29)
	No	11(22.9%)	10(10.4%)			
Practice hand washing at least 3 times	Yes	23(47.9%)	72(75%)	0.31(0.15-0.64)	0.0015	0.34(0.13-0.89)
	No	25(52.1)	24(25%)			
Have latrine	Yes	38(79.2%)	89(92.7%)	0.30(0.11-0.84)	0.0227	0.71(0.19-2.66)
	No	10(20.8%)	7(7.3%)			

statistically significant in bivariate analysis were included into the final mode of multivariate logistic regression analysis to determine potential risk factors (Table 5).

In multivariate logistic regression, contact with cases (AOR: 8.58, 95%CI: 3.02-24.41, P: 0.0001) and traditional gold mining (AOR: 6.34, 95%CL: 2.15-18.71, P: 0.0008) were found to be risk factors. The region especially the district where the Rotavirus outbreak happened is known with high deposit of gold mineral that the community has been practicing traditional gold mining. This practice brought a negative effect in child caring that parents left their children alone the whole day without care giver for mining. This in turn cause children to spend the day together which increases the chance of contact between sick and healthy individuals.

On the other hand, vaccination (AOR: 0.29, 95%CI: 0.11-0.75, P: 0.0108), history of similar illness (AOR: 0.18, 95%CI: 0.05-0.62, P: 0.0068) and practicing hand washing at least three critical times (AOR: 0.34, CI: 0.13-0.89, P: 0.0281) were found to be protective factors. Presence of first infection in children reduced the occurrence of the disease by about 82% after the infection which is proxy indicator for the development of immunity after first infection of Rotavirus (Table 5).

DISCUSSION

The study confirmed the existence of Rotavirus outbreak in Kurmuk district of Assosa zone, Benishangul-Gumuz region from Dec 22, 2018 to Feb 9, 2019. The regional health bureau declared the presence of Rotavirus outbreaks during the last two years in the same period. A study conducted on hospital-based surveillance for rotavirus gastroenteritis in children younger than 5 years of age in Ethiopia showed that studies Rotavirus circulated year-round with peak prevalence from October through January [16]. In other studies, Rotavirus prevalence high peaks were observed during dry seasons of the year [17-19]. Peak Rotavirus infection in Ghana was observed in cool dry months of January and February [20], due to Rotavirus among children <5years of age was decline only which agrees with the current study. While rotavirus infections have been called a winter disease in the temperate zones, their incidence peaked in winter primarily in the Americas and that peaks in the autumn or spring are common in other parts of the world. In the tropics, the seasonality of such infections is less distinct and within 10 degrees latitude (north or south) of the equator, eight of the ten locations exhibited no seasonal trend [21]. A study in Ukraine showed that an increase in Rotavirus prevalence was noticed in winter months [22] which is similar with the current outbreak.

Vaccination is the best way to prevent severe rotavirus disease and the deadly, dehydrating diarrhea that it causes. In high and middle-income countries, rotavirus vaccines confer 85-100% protection against severe disease, while in low-income regions of Africa and Asia, protection is less, at 46-77% [23]. In the current study, being vaccinated was protective against Rotavirus infection, which reduced the occurrence of a disease by 71% among vaccinated groups. After the introduction of vaccine in Thailand, Rotavirus related hospital admissions were reduced by 40%-69% [24]. Similarly, following the vaccine introduction in Kenya, the proportion of children aged <5years hospitalized for rotavirus declined by 30% in the first year and 64% in the second year. Reductions in rotavirus positivity were most pronounced among the vaccine-eligible group (<12months) in the first year post-vaccination at 42%. Greater reductions of 67% were seen in the second year in the 12-23 months age group [25]. In contrary to this, diarrhea hospitalizations by 17% from 24% in the pre-vaccine period to 20% in post-vaccine in Ethiopia. In the same study, a reduction of 18% of diarrhea hospitalizations due to Rotavirus in children <12months of age in the post-vaccine periods was observed [14]. Rotavirus vaccine has shown a major impact in hospital admission in Australia by reducing 71% of Rotavirus hospitalizations in under five years of age [3].

In the current study, children who had contact with cases of Rotavirus are 8.6 times more affected than those who hadn't contact with cases. A case-control study conducted for Rotavirus outbreak in South China found contact as risk factor that children who had contact with cases were 2.1 times more affected [26]. Similarly in an outbreak happened during the school trip, the study revealed that the disease was spread from a single pupil to classmates due to prolonged contact [27]. A study of infectious intestinal disease in England reported contact with cases as risk factor with Odds Ratio of 3.45 and P Value of < 0.001 [28], which agrees with current outbreak in Kurmuk district.

A study conducted in Guinea-Bissau to determine the Protective immunity after natural rotavirus infection reported that primary infection conferred 52% and 70% protection against subsequent rotavirus infection and

rotavirus diarrhea, respectively [29]. Another study also indicated that primary Rotavirus infection conferred protection against reinfection for more than two years [30]. Protection against moderate or severe disease increased with the order of infection but was only 79% after three infections. Early infection and frequent reinfection in a locale with high viral diversity resulted in lower protection than has been reported, providing a possible explanation why rotavirus vaccines have had lower-than-expected efficacy in Asia and Africa [31]. In the current study, the previous infection of Rotavirus reduced the subsequent reinfection by 82% which could be a serotype of best vaccine candidate.

The use of improved sanitation and hand washing are thought to be measured to reduce diarrheal diseases as indicated by a number of studies. In a study conducted in rural kebeles of Adama district, the prevalence of under-five child diarrheal was reduced due to improved handwashing practices in mothers/guardians of children [32]. Similarly, a study conducted in Arba Minch district highlighted that poor hand washing practice among mothers resulted in high risk of diarrheal diseases in under-five children [33]. Hand washing practice with soap during critical times and WASH educational messages reduces childhood diarrhea by 37% in Jigjiga district of Somali regional state [34]. In addition to the above studies, many other studies reported low practice of hand washing in communities resulted for high prevalence of diarrheal diseases in under-five children [35-37]. In the current study, those mothers/caretakers who has been practicing hand washing at least three times per day reduced the incidence of Rotavirus disease by 66%, which fairly agrees with above cited studies.

In this study, traditional gold mining was found to be statistical significant factor for the Rotavirus outbreak happened in the district. The Kurmuk district is known for high deposit of gold mineral that the community has been practicing traditional gold mining. Traditional gold mining practice in the district is high during winter because during this season most of the grass and bushes became dry and they set fire on them and the ground becomes suitable to locate gold deposit by sensor machines. This practice brought a negative effect in child caring that parents left their children alone the whole day without caretaker for mining. These children spent the day together and the chance of contact between sick and healthy, coming in contact with dirty materials are so high that contracting the disease is so high.

CONCLUSION AND RECOMMENDATIONS

Rotavirus outbreak was confirmed in the Kurmuk district and factors that increased the odds of Rotavirus infection in under-five children were contact with sick children and traditional gold mining whereas, being vaccinated, history of the previous infection with Rotavirus and mothers/caretakers practicing handwashing at least three times per day were found to be protective against Rotavirus infection.

Therefore, to prevent the Rotavirus outbreak in the future:

- Mothers should be educated on child caring, mode of diarrheal disease transmission and good hygiene practices.
- Vaccination coverage should be improved and factors that affect vaccine efficacy like cold chain should be assessed in the woreda.
- Identifying the genotype of Rotavirus circulating in the community is necessary and helps to know the reason why the previous infection is better protected than vaccination.

REFERENCES

1. GBD Diarrhoeal Diseases Collaborators, 2017. Estimates of global, regional and national morbidity, mortality and aetiologies of diarrhoeal diseases: a systematic analysis for the Global Burden of Disease Study 2015. Lancet Infect Dis., 17(9): 909-48.
2. Operario, D.J., J.A. Platts-Mills, S. Nadan, N. Page, M. Seheri, J. Mphahlele, I. Praharaj, G. Kang, I.T. Araujo, J. Leite, D. Cowley, S. Thomas, C.D. Kirkwood, F. Dennis, G. Armah, J.M. Mwenda, PR. Wijesinghe, G. Rey, V. Grabovac, C. Berejena and E.R. Houpt, 2017. Etiology of Severe Acute Watery Diarrhea in Children in the Global Rotavirus Surveillance Network Using Quantitative Polymerase Chain Reaction. The Journal of Infectious Diseases, 216(2): 220-7.
3. Bines, J.E. and C.D. Kirkwood, 2015. Conquering rotavirus: from discovery to global vaccine implementation. J. Paediatr Child Health, 51(1): 34-9.
4. Gurwith, M., W. Wenman, D. Hinde, S. Feltham and H. Greenberg, 1981. A prospective study of rotavirus infection in infants and young children. The Journal of Infectious Diseases, 144(3): 218-24.

5. Velázquez, F.R., D.O. Matson, J. Calva, L. Guerrero, A.L. Morrow, S. Carter-Campbell, R.I. Glass, M.K. Estes, L.K. Pickering and G.M. Ruiz-Palacios, 1996. Rotavirus infection in infants as protection against subsequent infections. N. Engl. J. Med., 335(14): 1022-8.
6. Parashar, U.D., E.G. Hummelman, J.S. Bresee, M.A. Miller and R.I. Glass, 2003. Global illness and deaths caused by rotavirus disease in children. Emerging Infectious Diseases, 9(5): 565-72.
7. Tate, J.E., A.H. Burton, C. Boschi-Pinto and U.D. Parashar, 2016. Global, Regional and National Estimates of Rotavirus Mortality in Children <5 Years of Age, 2000-2013. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America. 2016;1(62):S96-S105.
8. Troeger, C., I.A. Khalil, P.C. Rao, S. Cao, B.F. Blacker, T. Ahmed, G. Armah, J.E. Bines, T.G. Brewer, D.V. Colombara, G. Kang, B.D. Kirkpatrick, C.D. Kirkwood, J.M. Mwenda, U.D. Parashar, W.A. Petri, M.S. Jr, Riddle, A.D. Steele, R.L. Thompson, J.L. Walson and R.C. Reiner, 2018. Rotavirus Vaccination and the Global Burden of Rotavirus Diarrhea Among Children Younger Than 5 Years. JAMA Pediatr, 172(10): 958-65.
9. Liu, L., H.L. Johnson, S. Cousens, J. Perin, S. Scott, J.E. Lawn, I. Rudan, H. Campbell, R. Cibulskis, M. Li, C. Mathers and R.E. Black, 2012. Child Health Epidemiology Reference Group of WHO and UNICEF. Global, regional and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. Lancet, 379(9832): 2151-61.
10. World Health Organization. Vaccine Preventable Diseases Surveillance; Global Rotavirus Surveillance and Information Bulletin, Volume 10: January 2015. Available at: http://www.who.int/nuvi/surveillance/RV_bulletin_Jan 2015_Final.pdf. Accessed March, 2019.
11. Benishangul_Gumuz Region Health Bureau. Rotavirus outbreak in Kumruk distric, Benishangul-Gumuz region. Feb, 2019
12. Tate, J.E., A.H. Burton, C. Boschi-Pinto, A.D. Steele, J. Duque and U.D. Parashar, 2008 estimate of worldwide rotavirus-associated mortality in children younger than 5 years before the introduction of universal rotavirus vaccination programmes: a systematic review and meta-analysis. Lancet Infect Dis., 12(2): 136-41.
13. Federal Ministry of Health, Ethiopia. Routine immunization report. 2016.
14. Abebe, A., M. Getahun, S.L. Mapaseka, B. Beyene, E. Assefa, B. Teshome, M. Tefera, F. Kebede, A. Habtamu, T. Haile-Mariam, M. Jeffrey Mphahlele, F. Teshager, A. Ademe, T. Teka, G.G. Weldegebriel and J.M. Mwenda, 2018. Impact of rotavirus vaccine introduction and genotypic characteristics of rotavirus strains in children less than 5years of age with gastroenteritis in Ethiopia: 2011-2016. Vaccine, 36(46): 7043-7.
15. Taye, G., 2017. Rota virus outbreak investigation in Dano Woreda 2017.
16. Abebe, A., T. Teka, T. Kassa, M. Seheri, B. Beyene, B. Teshome, F. Kebede, A. Habtamu, L. Maake, A. Kassahun, M. Getahun, K. Mitiku and J.M. Mwenda, 2014. Hospital-based surveillance for rotavirus gastroenteritis in children younger than 5 years of age in Ethiopia: 2007-2012. Pediatr Infect Dis. J., 33(1): 0000000000000048.
17. Colston, J.M., A. Ahmed, S.B. Soofi, E. Svensen, R. Haque, J. Shrestha, R. Nshama, Z. Bhutta, I. Lima, A. Samie, L. Bodhidatta, A. Lima, P. Bessong, M. Paredes Olortegui, A. Turab, V.R. Mohan, L.H. Moulton, E.N. Naumova, G. Kang, M.N. Kosek, & Mal-Ed, 2018. network. Seasonality and within-subject clustering of rotavirus infections in an eight-site birth cohort study. Epidemiol Infect., 146(6): 688-97.
18. Chang, M.R., G. Velapatiño, M. Campos, E. Chea-Woo, N. Baiocchi, T.G. Cleary and T.J. Ochoa, 2015. Rotavirus seasonal distribution and prevalence before and after the introduction of rotavirus vaccine in a peri-urban community of Lima, Peru. Am. J. Trop. Med. Hyg., 92(5): 986-8.
19. Barril, P.A., T.M. Fumian, V.E. Prez, P.I. Gil, L.C. Martínez, M.O. Giordano, G. Masachessi, M.B. Isa, L.J. Ferreyra, V.E. Ré, M. Miagostovich, J.V. Pavan and S.V. Nates, 2015. Rotavirus seasonality in urban sewage from Argentina: effect of meteorological variables on the viral load and the genetic diversity. Environ Res., 138: 409-15.
20. Jason, M.M, M.N. Kinkela, A. Almaz, C. Enweronu-Laryea, A. Ismail, M. Jackson, K. Annet, M. Evans, P. Mpabalwani, Isoro, E. George, L.M. Armah, N.M. Seheri, N.P. Kiulia, W. Marc-Alain and S.A. Duncan, 2010. Burden and Epidemiology of Rotavirus Diarrhea in Selected African Countries: Preliminary Results from the African Rotavirus Surveillance Network. J. Infect. Dis. 202 Suppl: S5-S11. 2010.

21. Cook, S.M., R.I. Glass, C.W. LeBaron and M.S. Ho, 1990. Global seasonality of rotavirus infections. Bull World Health Organ, 68(2): 171-7.
22. Chernyshova, L.I., N.M. Radionova, I.V. Demchyshyna, L.S. Kotlik, O.B. Sadkova, E.O. Samoilovich, G.V. Semeiko, D.S. Daniels, A.L. Cohen, and N. Aliabadi, 2018. Observations on the epidemiology of rotavirus infection among hospitalized children younger than 5years in 2 Ukrainian hospitals, 2007-2015. Vaccine, 36(51): 7798-804.
23. Grimwood, K., S.B. Lambert and R.J. Milne, 2010. Rotavirus infections and vaccines: burden of illness and potential impact of vaccination. Paediatr Drugs., 12(4): 235-56.
24. Tharmaphornpilas, P., S. Jiamsiri, S. Boonchaiya, O. Rochanathimoke, W. Thinyounyong, S. Tuntiwitayapun, R. Guntapong, A. Riewpaiboon, A.O. Rasdjarmrearnsook and R.I. Glass, 2017. Evaluating the first introduction of rotavirus vaccine in Thailand: Moving from evidence to policy. Vaccine, 35(5): 796-801.
25. Wandera, E.A., S. Mohammad, M. Bundi, S. Komoto, J. Nyangao, C. Kathiiko, E. Odoyo, G. Miring'u, K. Taniguchi and Y. Ichinose, 2017. Impact of rotavirus vaccination on rotavirus and all-cause gastroenteritis in peri-urban Kenyan children. Vaccine, 35(38): 5217-23.
26. Li, Y., H. Guo, W. Xu, T. Wu, H. Ma and R.E. Fontaine, 2011. A community outbreak of rotavirus diarrhea associated with exposures in a hospital outpatient department in South China. Pediatr Infect Dis J., 30(9): 745-8.
27. Mikami, T., T. Nakagomi, R. Tsutsui, K. Ishikawa, Y. Onodera, K. Arisawa and O. Nakagomi, 2004. An outbreak of gastroenteritis during school trip caused by serotype G2 group A rotavirus. J. Med. Virol., 73(3): 460-4.
28. Sethi, D., P. Cumberland, M.J. Hudson, L.C. Rodrigues, J.G. Wheeler, J.A. Roberts, D.S. Tompkins, J.M. Cowden and P.J. Roderick, 2001. A study of infectious intestinal disease in England: risk factors associated with group A rotavirus in children. Epidemiol Infect., 126(1): 63-70.
29. Fischer, T.K., P. Valentiner-Branth, H. Steinsland, M. Perch, G. Santos, P. Aaby, K. Mølbak and H. Sommerfelt, 2002. Protective immunity after natural rotavirus infection: a community cohort study of newborn children in Guinea-Bissau, west Africa. The Journal of Infectious Diseases, 186(5): 593-7.
30. Bernstein, D.I., D.S. Sander, V.E. Smith, G.M .Schiff and R.L. Ward, 1991. Protection from rotavirus reinfection: 2-year prospective study. The Journal of Infectious Diseases, 164(2): 277-83.
31. Gladstone, B.P., S. Ramani, I. Mukhopadhya, J. Muliyil, R. Sarkar, A.M. Rehman, S. Jaffar, M.I. Gomara, J.J. Gray, D.W. Brown, U. Desselberger, S.E. Crawford, J. John, S. Babji, M.K. Estes and G. Kang, 2011. Protective effect of natural rotavirus infection in an Indian birth cohort. N Engl. J. Med., 365(4): 337-46.
32. Regassa, W. and S. Lemma, 2016. Assessment of Diarrheal Disease Prevalence and Associated Risk Factors in Children of 6-59 Months Old at Adama District Rural Kebeles, Eastern Ethiopia, January/2015. Ethiop J. Health Sci., 26(6): 581-8.
33. Mohammed, S. and D. Tamiru, 2014. The Burden of Diarrheal Diseases among Children under Five Years of Age in Arba Minch District, Southern Ethiopia and Associated Risk Factors: A Cross-Sectional Study. Int. Sch. Res. Notices, 18 (654901).
34. Hashi, A., A. Kumie and J. Gasana, 2017. Hand washing with soap and WASH educational intervention reduces under-five childhood diarrhoea incidence in Jigjiga District, Eastern Ethiopia: A community-based cluster randomized controlled trial. Prev. Med. Rep., 6: 361-8.
35. Gebru, T., M. Taha and W. Kassahun, 2014. Risk factors of diarrhoeal disease in under-five children among health extension model and non-model families in Sheko district rural community, Southwest Ethiopia: comparative cross-sectional study. BMC Public Health, 14(395): 1471-2458.
36. Gizaw, Z., W. Woldu and B.D. Bitew, 2017. Child feeding practices and diarrheal disease among children less than two years of age of the nomadic people in Hadaleala District, Afar Region, Northeast Ethiopia. Int Breastfeed J., 12(24): 017-0115.
37. Bitew, B.D., W. Woldu and Z. Gizaw, 2017. Childhood diarrheal morbidity and sanitation predictors in a nomadic community. Ital. J. Pediatr., 43(1): 017-0412.