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## Reduction of hospitalizations with diarrhea among children aged 0–5 years in Nouakchott, Mauritania, following the introduction of rotavirus vaccine

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### Abstract

**Introduction:** Rotavirus vaccine was introduced in Mauritania in December 2014. We investigated hospitalizations with diarrhea during pre and post-vaccination periods among children aged 0–5 years in Nouakchott, the capital of Mauritania.

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#### Authors' contributions:

ML Ch Br A and JH performed statistical analysis, drafted and edited the manuscript. WA, MS, KM, DA coordinated and supervised the data acquisition. AFM, ACCA, MVEM, SD, JET, UDP and BM revised critically the manuscript. All authors approved the submission.

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**Methods:** We conducted a retrospective review of hospital admission registries from November 1<sup>st</sup> 2012 through October 31<sup>th</sup> 2017 at all referral hospitals in Nouakchott. We described admissions of children aged <5 years by diagnosis, data of admission, age and sex, and compared the proportion of all childhood hospitalizations with diarrhea before and after rotavirus vaccine introduction.

**Results:** In total, 6,552 (19%) of all 34,329 hospitalizations in <5 year-olds had diarrhea. Of these, 3,523/16,952 (20.7%) were recorded during the pre-vaccine period, 1,373/6,897 (19.9%) during the transition period (November 2014–October 2015), and 1,656/10,480 (15.8%) during the post-vaccination period. The proportion of all childhood hospitalizations with diarrhea during the pre-vaccine period was 22.6% among males and 18.7% among females. Approximately one third (32.3%) of hospitalizations with diarrhea occurred in children aged 6–11 months. During the post-vaccination period, the proportion of hospitalizations with diarrhea declined by 24%, and the highest reduction (74%) was observed in children aged 2 to 5 years ( $P < 0.001$ ).

**Conclusions:** The proportion of childhood hospitalizations with diarrhea in Nouakchott was reduced by about one fourth after introduction of rotavirus vaccination in Mauritania, indicating a major impact for public health for children in the capital city.

### Keywords

Diarrhea; Rotavirus; Vaccine; Nouakchott; Mauritania

## Introduction

Diarrhea is the leading cause of morbidity and mortality among children under 5 years of age in the developing world (1). Rotavirus is the most common cause of diarrhea-associated hospitalization in this age group (2,3). Globally, diarrhea accounted for 0.6 million deaths and rotavirus for 215,000 deaths among children aged 0–5 years in 2013 (4–7). Consequently, the World Health Organization recommends rotavirus vaccines (RV) for routine immunization in all countries (8). In Mexico, RV contributed to a 38% and 50% of reduction in diarrhea-associated hospitalizations and deaths, respectively (9,10). On the African continent, around 134,700 hospitalizations and 21,000 deaths were prevented in 2016, after implementation of rotavirus vaccine in children (11).

The burden of rotavirus-associated hospitalizations among Mauritanian children has been considered as extremely high, but systematic data are scarce. A recent study focusing on the pre-vaccination era has shown that 22.4% of all hospitalizations and 14.1% of deaths among hospitalized children in Mauritania were caused by diarrhea (12). In 2008, a cross-sectional survey conducted in two districts of Mauritania's capital Nouakchott found that 23.6% of children aged 0–5 years had diarrhea and 52% of cases were associated with poor hygiene (13). A more recent study indicated that global prevalence of diarrhea disease, in 9 municipalities of Nouakchott city, was 12.8% (ranging from 9.1% in Tevrehg zeina to 19.1% in Sebkhah), with the majority of cases (51.7%) registered among children aged 0–5 years (14). In 2016, the Global Burden of Diseases study estimated that diarrhea was associated with 10.5% of deaths. Unsafe water, inadequate sanitation, and environmental

and occupational risks were associated with 29.6% of total deaths among children aged 0–5 years in Mauritania (15).

Mauritania officially introduced Rotarix vaccine in December 2014 in the entire country with 2 doses for children aged 6 and 10 weeks. In Nouakchott city, the vaccine coverage increased from 6% in 2014, to 51% in 2015, 76% in 2016 and 81.5% in 2017 (14). The objective of this study was to provide further data on the impact of RV introduction on a population level, by using as an indicator the proportion of all childhood hospitalizations with diarrhea before and after the introduction of RV in Nouakchott city.

## Methods

### Setting

We performed a hospital-based study including all four Referral Hospitals located in Nouakchott city, namely the National Hospital, Amitie Hospital, Cheikh Zaid Hospital and Mother-Child Hospital. Nouakchott is the capital of Mauritania with about 1 million inhabitants corresponding to one-fourth of the population of the country (16).

### Data collection

We conducted a retrospective study including data from November 1<sup>st</sup> 2012, when two new hospitals were established and started to operate in Nouakchott city, to October 31<sup>th</sup> 2017. We extracted from the registries of the Hospitals' pediatric services. Data collected included age, sex, admission dates and diagnosis. The cases were identified using by admissions that had one of the terms in the table 1, listed as an admitting diagnosis in the pediatric ward registry. We included all cases <5 years of age at admission with at least one of these diagnoses at admission.

### Data analysis

We used Microsoft Office Excel 2007 and Statistical Package for the Social Sciences (SPSS version 22) for data entry and analysis, using chi-square (fisher's exact) and two-sample t-test for comparison between pre and post proportions for sex and age groups. We present the number of children, who were hospitalized with diarrhea at the all referral hospitals during pre, transition and post-vaccination periods. We divided hospitalizations children into three groups, children hospitalized from 1 November 2012 until 31 October 2014 (pre-vaccination period), children hospitalized between 1 November 2014 until 31 October 2015 (transition period, as unofficially vaccination started in November 2014) and children hospitalized from 1 November 2015 until 31 October 2017 (post-vaccination period).

## Results

A total of 34,329 hospitalizations were recorded during the study period, distributed over the four hospitals (Table 2). Of these hospitalizations, 6,552 (19%) were classified as having diarrhea among children aged 0–5 years. In the pre-vaccine period, a total of 3,523/16,952 (20.8%) hospitalizations had diarrhea in <5 year-olds, and after introduction of vaccination,

1,656/10,480 (15.8%), a relative reduction of 24% (Table 3). During the transition period, 1,373/6,897 (19.9%) hospitalizations had diarrhea in <5 year-olds.

As shown in Table 3, the reduction of the proportion of hospitalizations with diarrhea was significantly associated with age groups and period of admission. The most prominent reduction (74%) was observed in 2–5 year-olds. The seasonality in diarrhea-associated hospitalizations was shown in figure 1.

Figure 2 shows that during the observation period, the total number of admissions and the admissions with diarrhea in <5 year-olds reduced steadily. The relative frequency of admissions with diarrhea reduced from 22.4% in the first observation period, to 15.3% in the last period.

## Discussion

After rotavirus vaccine introduction in Mauritania, the proportion of childhood hospitalizations with diarrhea in Nouakchott declined by nearly one-fourth. The high reduction that we reported occurred specifically among children that are eligible to get vaccination and consistent with increasing vaccine coverage. Admissions among children <2 months of age with diarrhea increased in the post-vaccine era but this may be because children in this age group are not yet eligible to receive rotavirus vaccine. The reductions were seen in the 3 month to 5 years age group, which is known to be eligible for vaccination. Collectively, these findings support a role of rotavirus vaccination in the observed declines in childhood diarrhea hospitalizations.

In studies done in South Africa, the RV was associated with a 34% to 57% of reduction in the overall incidence of all cause diarrhea hospitalizations and the highest reduction was observed among children aged less than 1 year (18). In studies done in Mexico, the vaccine was associated with 50% of reduction during post-vaccination period (10). Our findings are consistent with these observations and support the hypothesis that the reduction in all-cause diarrhea associated hospitalization can be attributed partly to the introduction of RV.

In our study, diarrhea was associated with about one fifth of all hospitalizations during pre-vaccine period. This was in line with previously study conducted in two districts of Nouakchott in 2008 which has shown that the prevalence of diarrhea in children aged 0–5 years was 23.6% (ranging from a low of 16.8% in Tevregh zeina to a high of 28.3% in Sebkha) (13). According to other household surveys conducted in Nouakchott city, 50.8% of health care admissions were due to respiratory and diarrhea diseases (19).

Our hospital-based study has several limitations, including quantity (such as missing information) and quality (such as diagnostic errors) of hospital data, as well as limited number of variables that can be analyzed. We identified diarrhea hospitalizations based on admission diagnosis rather than discharge diagnosis which may have resulted in the misclassification of some cases. In addition, rotavirus testing is not routinely performed in Mauritania; we could provide data on rotavirus-specific diarrhea hospitalizations and used all-cause diarrhea associated hospitalization. Other factors such as changes in the socioeconomic status among populations or in quantity and quality of health care

services in Nouakchott city, can also contribute to the reduction in annual diarrhea-associated hospitalization, rather than the more accelerated decline that we observed in post-vaccination period. As the data abstracted from all referral hospitals in Nouakchott city, which represent a quarter of the Mauritanian population, results may be indicative for hospitalized children in the entire country.

We conclude that rotavirus vaccine introduction likely had a significant impact on and reduced the burden of hospitalizations with diarrhea among children aged 0–5 years in Nouakchott, Mauritania.

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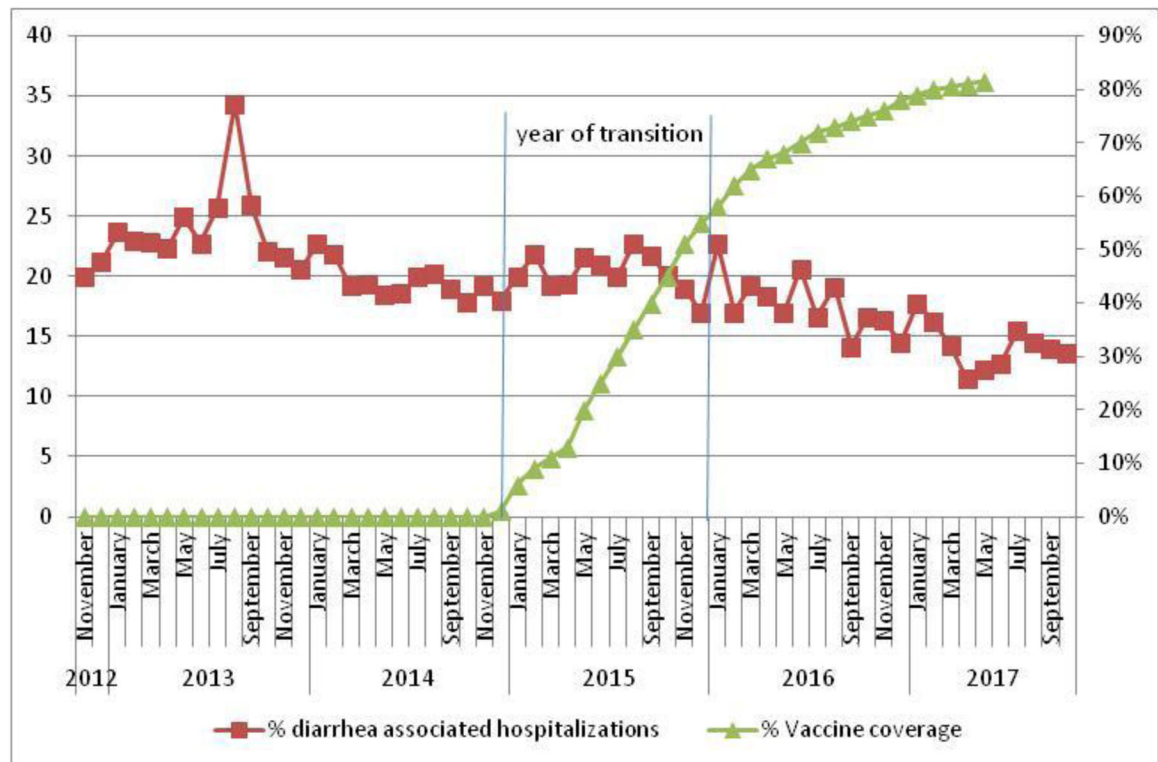
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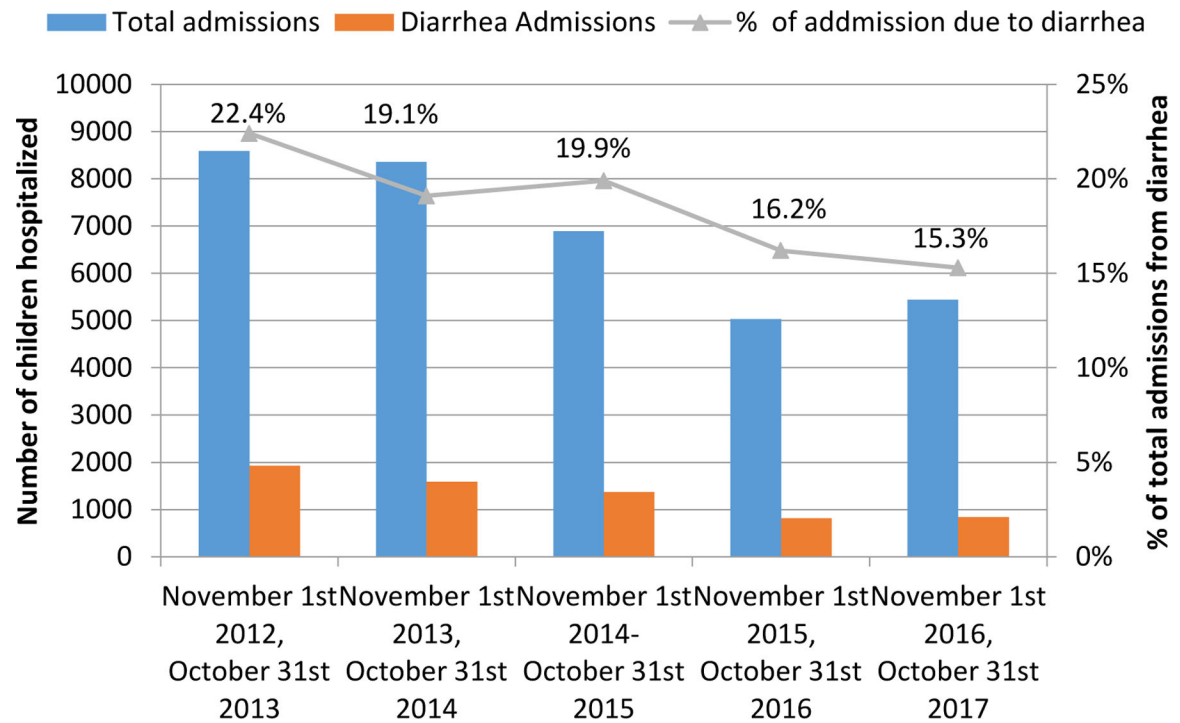
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**Figure 1:**

Monthly variation of cases of diarrhea, stratified by months. x-axis: months of the year; y-axis left side: proportion of hospitalizations with diarrhea in <5 year-olds, y-axis right side: % of coverage vaccine in Nouakchott.





**Figure 2:**  
Total admissions, admissions with diarrhea, and relative frequency of admissions with diarrhea in <5 year-olds, according to period of admission.



**Table 1:**

Case definitions of diarrhea diseases used for data abstraction

<b>Diarrhea</b>
Acute diarrhea
Diarrhea (infective or not infective)
Gastroenteritis (febrile or not febrile)
Acute gastroenteritis (febrile or not febrile)
Gastroenteritis (infective or not infective)
Gastrointestinal
Dehydration
Dysentery
Gastroenteritis and colitis
Enteritis
Viral enteritis

**Table 2:**

Proportion of all childhood hospitalizations with diarrhea in <5 year-olds, by hospital and time period.

Characteristics	N (%)
<b>Hospital</b>	
National hospital	1,771/9,440 (18,7%)
Amitie hospital	1,614/8,411 (19,2%)
Cheikh Zaied hospital	1,482/7,552 (19,6%)
Mother-Child hospital	1,685/8,926 (18,9%)
<b>Period of admission</b>	
Pre-vaccine period:	
November 1 <sup>st</sup> 2012, October 31 <sup>st</sup> 2013	1929/8,588 (22,4%)
November 1 <sup>st</sup> 2013, October 31 <sup>st</sup> 2014	1594/8,364 (19,1%)
Year of transition:	
November 1 <sup>st</sup> 2014- October 31 <sup>st</sup> 2015	1,373/6,897 (19,9%)
<b>Post vaccine period</b>	
November 1 <sup>st</sup> 2015, October 31 <sup>st</sup> 2016	819/5,036 (16,2%)
November 1 <sup>st</sup> 2016, October 31 <sup>st</sup> 2017	837/5,444 (15,3%)

**Table 3:**

Hospitalizations with diarrhea before and after introduction of rotavirus vaccine in <5 year-olds, stratified by sex and age.

Variable	Pre-vaccine (2012–2014) Diarrhea/total hospitalizations N (%)	Post-vaccine (2015–2017) Diarrhea/total hospitalizations N (%)	P-value*	Relative reduction N (%)
<b>Sex</b>				
Male	1,998/8,832 (22,6%)	909/5,460(16,6%)	0.88	22,6%
Female	1,525/8,120 (18,7%)	774/5,020(15,4%)		17,6%
<b>Age</b>				
0–2 months	867/5880 (14,7%)	583/3398 (17,1%)	<0.0001	2,4% (increase)
3 months <1 year	1,109/4791(23,1%)	618/3199 (19.3%)		16,4%
1 year < 2 years	1,159/3,733 (31%)	394/2,308 (17,1%)		44,8%
2 years < 5 years	388/2,548 (15,2%)	61/1,575 (3,9%)		74,3%
<b>Total</b>	<b>3,523/16,952 (20,8%)</b>	<b>1656/10,480 (15,8%)</b>	<b>&lt;0.0001</b>	<b>24%</b>

\* P-values compare distributions pre- and post-vaccine introduction.