Economic assessment of rotavirus vaccination in Saudi Arabia

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ABSTRACT

In the Kingdom of Saudi Arabia (KSA), rotavirus universal mass vaccination has been introduced in 2013, however, there is limited information available on the economic benefit and the epidemiological impact of the programme to date.

We used a Markov cohort model to evaluate and compare the economic value of rotavirus vaccination with no vaccination in a birth cohort of 562,428 infants. This lifetime analysis considered the societal perspective. Model input was obtained through consensus of local experts after two rounds of evaluation of the proposed estimates. The primary outcome measure was to assess cost-effectiveness and to define the cost-neutrality level reached by comparing vaccination with no vaccination as a function of the price adjustment of the vaccination course.

With an assumed vaccine coverage rate of 96%, the already started rotavirus vaccination is expected to reduce the overall burden of rotavirus gastroenteritis by 65% with model exercise, over lifetime. The maximum impact will be seen in rotavirus gastroenteritis-related hospitalizations (93%). Outpatient and emergency visits are shown to decline by 87% each while the occurrence of nosocomial infections, by 78%. Cost neutrality is reached if the vaccine price per course is less than SAR 178.20 at steady state.

Rotavirus vaccination should be recommended in KSA given the important clinical impact the vaccine can have and the good value for money it can obtain.

Introduction

Globally, rotavirus gastroenteritis (RVGE) is one of the most common causes of severe acute gastroenteritis (GE) in children aged ≤5 years. Symptoms of RVGE include diarrhea, vomiting, fever and dehydration. In severe cases, hospitalization is necessary to provide adequate rehydration of the child [1,2]. RV is also one of the leading causes of nosocomial infection in children hospitalized for other reasons [3–5]. RVGE is also known to have a significant impact on the quality of life of both, children and their caregivers resulting in a considerable time reduction of good quality-adjusted life years (QALYs) [6]. The highest burden of RVGE cases occurs in children of ages ranging between 6 and 24 months. The incidence of RVGE in infants below 6 months of age is lower due to breast-feeding and the presence of circulating maternal antibodies which could protect the child against some infections [2,7]. In temperate climates the majority of RVGE cases are observed during the winter months [2,3,5]. However, the seasonality of the disease in the more tropical climates is less marked [5]. The disease is normally managed through fluid replacement to prevent dehydration and through zinc treatment to decrease the severity and the duration of the acute GE episode [2]. But the current treatment of RVGE is targeted at relieving the symptoms and therefore does not eliminate the disease or the infection. Today RVGE remains a recurrent public health problem. Alternatively, RVGE disease burden could be managed through the implementation of vaccination.

In 2009, the World Health Organization has recommended the inclusion of RV vaccines in national immunization programs of all countries worldwide, and considered a priority in countries with high RVGE-related mortality rates [2]. Two orally administered rotavirus vaccines which have demonstrated good efficacy against the disease with an acceptable safety record in randomized clinical trials, have been licensed in most countries: *Rotarix*[TM] (GSK Vaccines, Belgium, RIX4414) and *RotaTeq*[TM] (Merck and Co., Inc.,

Whitehouse Station, NJ, USA). While the widespread evaluation of rotavirus vaccination has consistently demonstrated high levels of protection against severe RVGE in robust, large-scale trials and real-world settings [8–13], the implementation of rotavirus vaccination through routine infant immunization has been much debated over and most often about the total value of the vaccine and its cost affordability [14,15]. Economic assessment, using models, is therefore a helpful tool to demonstrate the potential financial benefit when introducing new interventions such as vaccination.

In the Kingdom of Saudi Arabia (KSA) rotavirus infection is associated with a significant morbidity and healthcare resource utilization leading to a high spending in direct medical cost and a high increase in indirect cost because of work absenteeism resulting from staying at home to provide care for the sick child [14–20]. Rotarix vaccine was introduced in 2013 in the KSA routine immunization against RVGE. However, there is no data that provides information on the economic value of Rotarix introduction for KSA. In the current immunization programme, we aimed to analyze Rotarix comparing no vaccination as base case. The objective of this modeling exercise was to assess the cost-effectiveness of rotavirus vaccination or whether it may lead to cost-savings. In addition, a budget impact analysis was performed to understand when and how significant cost offsets may occur while using different vaccine uptake scenarios.

Methods

Model structure overview

A previously described age-compartmental Markov cohort model with monthly cycles was used for this economic analysis to represent different health states over time—risk for RV for the first time, being at risk after first RVGE episode, not being at risk and death [21,22]. The model simulates the vaccine effect in a hypothetical infant cohort (n = 562,428, birth cohort, reference year 2012) and steady-state level is reached over a period of 5 years (= the at-risk period) [23]. The analysis was conducted from a societal perspective (including productivity loss) and considered a lifetime horizon with an average life expectancy of 75 years to evaluate the survival benefit of deaths avoided because of vaccination [23]. The disease management decision tree was built as a time-driven, dichotomized event-related process where a child at birth is exposed each subsequent month with a certain probability to an episode of RVGE or not with monthly cycles. This event may lead to either a consultation of a medical practitioner, or not: first line (General Practitioner, homecare, and pediatrician) or second line (emergency room visit). The medical visit (first line) will be followed by either an emergency room visit or not, and subsequently by a hospitalization or not. During hospitalization, death caused by the infection may or not occur. Once discharged from the hospital or after the first episode of RVGE a subject aged <5 years is at the risk of contracting a second RV infection which may again lead to

Table 1
Model input data.

Category	Minimum	Maximum	Consensus	Reference
Annual birth cohort			**562,428**	[23]
All RVGE-related events in children aged ≤5 years	*129,300*	*168,700*	*153,200*	*Delphi panel*
Seeking medical advice	*112,500*	*140,600*	*122,400*	
Emergency visits	*16,800*	*39,400*	*30,600*	
Hospitalization	*10,123*	*16,800*	*10,172*	
Nosocomial RVGE	*2200*	*5600*	*2500*	
Deaths	*22*	*22*	*22*	
Duration of RVGE-related events in children aged ≤5 years				
RVGE episode	*5 days*			*Delphi panel*
Hospitalization	*4 days*			Khalil et al. [34]
Additional duration of hospitalization due to nosocomial RVGE	*4 days*			Khalil et al.[34]

Vaccine efficacy	Dose 1	Dose 2 (year 1)	Dose 2 (year 2)	
All RVGE per year	*87.1%*	*87.1%*	*71.9%*	Vesikari et al.[26]
Seeking medical advice	*89.8%*	*91.8%*	*76.2%*	
Hospitalization	*89.8%*	*100.0%*	*92.2%*	
Nosocomial RVGE	*89.8%*	*100.0%*	*92.2%*	De Vos et al.[27]
Deaths	*89.8%*	*100.0%*	*92.2%*	
Overall vaccine coverage (dose 1 and 2)	**96%**			Assumption
Vaccine cost per unit dose (SAR)	**82**	**90**	**85**	Assumption
Direct medical costs (SAR)				*Delphi panel*
Medical visit	*200*	*250*	*250*	
Emergency visit	*300*	*400*	*400*	
Hospitalization	*3000*	*4000*	*3600*	
Nosocomial RVGE	*2000*	*4000*	*3600*	
Indirect cost (SAR)				
Labor cost per day per woman	*150*	*200*	*200*	
Discount rate				WHO guideline [30]
Cost	*3%*			
QALY	*3%*			
Proportion women working in KSA	*12%*	*17%*	*15%*	*Delphi panel*

Disutility scores of RVGE-related events in children aged <5 years	Ages <18 months	Ages 18 months-5 years	
Diarrhea	*−0.109*	*−0.156*	Martin et al. [6]
First line visit	*−0.219*	*−0.312*	
Emergency visit	*−0.575*	*−0.575*	
Hospitalization	*−0.600*	*−0.800*	
Nosocomial infection	*−0.575*	*−0.800*	

RVGE, rotavirus gastroenteritis; QALY, quality-adjusted life years, A&E, accident and emergency.