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Coverage and cost of a large oral cholera vaccination program in a high-risk cholera endemic urban population in Dhaka, Bangladesh☆

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ABSTRACT

A feasibility study of an oral cholera vaccine was carried out to test strategies to reach high-risk populations in urban Mirpur, Dhaka, Bangladesh. The study was cluster randomized, with three arms: vaccine, vaccine plus safe water and hand washing practice, and no intervention. High risk people of age one year and above (except pregnant woman) from the two intervention arms received two doses of the oral cholera vaccine, Shanchol™. Vaccination was conducted between 17th February and 16th April 2011, with a minimum interval of fourteen days between two doses. Interpersonal communication preceded vaccination to raise awareness amongst the target population. The number of vaccine doses used, the population vaccinated, left-out, drop out, vaccine wastage and resources required were documented. Fixed outreach site vaccination strategy was adopted as the mode of vaccine delivery. Additionally, mobile vaccination sites and mop-up activities were carried out to reach the target communities. Of the 172,754 target population, 141,839 (82%) and 123,666 (72%) received complete first and second doses of the vaccine, respectively. Dropout rate from the first to the second dose was 13%. Two complete doses were received by 123,661 participants. Vaccine coverage in children was 81%. Coverage was significantly higher in females than in males (77% vs. 66%, $P < 0.001$). Vaccine wastage for delivering the complete doses was 1.2%. The government provided cold-chain related support at no cost to the project. Costs for two doses of vaccine per-person were US$3.93, of which US$1.63 was spent on delivery. Cost for delivering a single dose was US$0.76. We observed no serious adverse events. Mass vaccination with oral cholera vaccine is feasible for reaching high risk endemic population through the existing national immunization delivery system employed by the government.

1. Introduction

Provision of safe food and water, adequate sanitation, implementation of personal and community hygiene are considered as public health interventions to prevent and control diarrheal diseases. The most vulnerable to these diseases live in developing countries where quick and full implementation of these measures in the near future is unlikely due to lack of funds and infrastructure. In emergencies following man-made or natural disasters, such measures are unlikely to be implemented timely. Previously, vaccination has not been considered as a control measure for endemic cholera because of concerns with vaccine efficacy, availability, costs and feasibility. Failure of standard prevention and control measures in low-income countries has increased the acceptability of cholera vaccination as an additional public health prevention and control tool in resource poor settings [1–6].

Field trials of the oral cholera vaccine (OCV) "Dukoral" in Bangladesh, Peru and Mozambique, conferred 60–85% protection for six month following vaccination in infants and around 60% protection for two years in older children and adults [7–9]. In 2009, a new OCV, "Shanchol™" (Shantha Biotechnics Limited, Hyderabad,

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India), was licensed in India and was prequalified by WHO in 2011 [10]. It had an overall protective efficacy of 66% against culture-confirmed cholera in 3 years following administration [11]. Results of OCVs tested in endemic settings have shown both direct and indirect herd protection [7,12,13]. In 2011, WHO recommended that OCVs be used in areas with endemic cholera, in epidemics, and in areas at risk of outbreaks as an additional public health tool. With limited resources, high-risk groups should be prioritized for vaccination [14–16].

In 2011, a mass vaccination was carried out in an endemic urban area with Shanchol™ to determine feasibility to reach the high-risk urban population and to evaluate impact in reducing cholera. The specific objectives were to evaluate adoption strategies, in terms of acceptability, coverage, accessibility, resource requirements, sustainability and vaccination effectiveness. This paper discusses the coverage and cost of the vaccination program.

2. Materials and methods

2.1. Study site and population

The feasibility study on OCV was carried out in Mirpur, an urban setting in the metropolitan area of Dhaka with an estimated population of 2.8 million. The hospital of the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) treats more diarrheal patients from Mirpur than from any other part of Dhaka. Based on the patient records from year 2005 to 2009, six of the sixteen wards in Mirpur had high cholera hospitalization rates (2–6/1000) (Fig. 1) [17].

Hospital records indicated that the majority of the cholera patients came from high risk settings, typically characterized by, overcrowded households, poor living conditions, unsafe water use, poor sanitation and hygiene practices and shared water source, toilet facility and kitchen. A census was carried out to register the high-risk population in these wards. Based on the satellite image of the area, digitized maps were prepared. Census teams then updated the maps, visited each building and ascertained whether or not people were living there. Households that matched at least one of the criteria mentioned above, were selected as high risk for cholera. Information were collected from households after verbal consent of the respondents. A questionnaire prepared for the study was customized in the personal digital assistants (PDA) to collect information. Supervisors subsequently verified the field workers assessment of high risk population. Thus, 316,766 high-risk residents were identified in the selected wards. A unique number code was assigned to each individual and relevant socioeconomic, demographic, and healthcare information was collected.

2.2. Cluster and randomization

The study area was divided into 90 geographic clusters. A cluster was defined as an area with high-risk target population living in the specific structure/households in the area. The low cholera risk people living in the cluster area were excluded from the study. The average number of high risk targeted population in each cluster was approximately 2749 when they were formed. Each cluster was separated from adjoining cluster by the buildings and residents in a 30 meters buffer area, assuming it would minimize transmission between clusters, because such transmission could attenuate measured estimates of vaccine induced herd effect [18]. The clusters were randomized into three arms, each having 30 clusters. These were two intervention arms-cholera vaccine alone; cholera vaccine plus safe water with hand washing and a non-intervention arm that continued standard habits and practices. Through pre-intervention census, eligible individuals were listed and a bar-coded card issued to identify the participants. During card distribution and at the vaccination sessions, the newly in-migrated high risk people were also included in the cluster-wise master lists and micro plans for vaccine delivery. Age of children and pregnancy status of all married women of child bearing age were recorded during the census update as well as before vaccination to include or exclude them from vaccination target. Age of the child was recorded from EPI card, birth certificate, when available, or taken through respondents history. Children less than one year at the time of vaccination were not targeted for vaccination. If women were unable to state about their pregnancy status, they were asked for their last menstrual period (LMP). If LMP exceeded more than four weeks and in doubtful cases, women were not targeted for vaccination. During vaccination, the eligible targeted population (cholera high risk individuals excluding <1 year and pregnant woman) in the 60 intervention clusters totalled 172,754.

2.3. Vaccine

Each 1.5 ml dose of the liquid bivalent Shanchol™ vaccine contains inactivated whole-cell heat-killed and formalin-killed *Vibrio cholerae* O1 and O139. The vaccine has no detectable levels of cholera toxin [19]. A randomized placebo controlled trial in 330 Bangladeshi participants in three age groups, undertaken prior to the mass vaccination showed that the vaccine is safe and immunogenic [20].

2.4. Implementation of mass vaccination with OCV

2.4.1. Communication strategy and social mobilization

Due to the cluster-randomized design and non-eligible population in the neighborhood, limited population mobilization activities were undertaken. Communication strategy involved only interpersonal communication by the field workers and focal advocacy meetings. Prior to vaccination, trained workers and volunteers visited each target household to distribute cards, present the messages related to cholera, OCV, vaccination activities and secure signed consent for participation. Communities were reminded by the volunteers about their vaccination date and time and to bring the ID card to the vaccination site. Targeted cell-phone messages and banners at vaccination sites were used to create awareness and encourage participation.

2.4.2. Vaccine delivery strategy and implementation

To avoid conflict with the national immunization day (NID) for polio eradication planned in January–February, 2011, the program was delayed by a month. This was done to ensure government support for cold space and cold chain logistics. But the downside of this shift was that the program had to be implemented at the beginning of the diarrhea/cholera season in Dhaka.

Vaccine delivery in this cluster randomized design with different interventions differed greatly from general mass vaccination programs [2–4,7]. For the best use of available resources and completing the program within the shortest possible time, fixed outreach site vaccine delivery strategy along with mop-up activities compatible to national immunization service delivery practices was adopted to deliver two doses of Shanchol™ at minimum fourteen days interval. The targeted population in each cluster was distributed among three fixed outreach vaccination sites where three vaccination teams covered 2700–3000 participants in three days. The sixty vaccine clusters were grouped into five cycles. In each 3-day vaccination cycle, 12 clusters were covered by thirty-six vaccination teams in each day (Fig. 2a and b). The teams then moved on to the next cycle and thus all clusters were covered two times in two rounds.