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Successive introduction of four new vaccines in Rwanda: High coverage and rapid scale up of Rwanda's expanded immunization program from 2009 to 2013

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ABSTRACT

As the pace of vaccine uptake accelerates globally, there is a need to document low-income country experiences with vaccine introductions. Over the course of five years, the government of Rwanda rolled out vaccines against pneumococcus, human papillomavirus, rotavirus, and measles & rubella, achieving over 90% coverage for each. To carry out these rollouts, Rwanda's Ministry of Health engaged in careful review of disease burden information and extensive, cross-sectoral planning at least one year before introducing each vaccine. Rwanda's local leaders, development partners, civil society organizations and widespread community health worker network were mobilized to support communication efforts. Community health workers were also used to confirm target population size. Support from Gavi, UNICEF and WHO was used in combination with government funds to promote country ownership and collaboration. Vaccination was also combined with additional community-based health interventions. Other countries considering rapid consecutive or simultaneous rollouts of new vaccines may consider lessons from Rwanda's experience while tailoring the strategies used to local context.

1. Introduction

Access to vaccines in many of the poorest countries has risen dramatically in recent years with improvements in health care delivery systems, the advent of new funding, monitoring and evaluation mechanisms, and increased global connectivity. Partnerships with multilateral organizations including the World Health Organization (WHO) and UNICEF to launch and bolster nationally-owned and managed immunization programs significantly accelerated progress toward meeting the international targets for child survival, including the 2015 Millennium Development Goals.

Twenty years ago in Rwanda, child survival plummeted as a result of the 1994 genocide during which one million people were killed. Often overlooked in this period of history were the major short- and long-term health impacts of the violence on newborns and young children. In the years that followed the genocide, more than one in four children would die of preventable causes before their fifth birthday [1]. With a national health system that was all but destroyed, coverage of most WHO-recommended immunizations plummeted below 25% in 1994 (Fig. 1) [2].

Yet, over the past two decades, Rwanda has been able to not only rebuild its Expanded Program on Immunization but also to increase its scope to include vaccination against 12 pathogens with coverage rates above 90% [3].

Abbreviations: PCV, pneumococcal conjugate vaccine; HPV, human papillomavirus; MR, measles–rubella; MDG's, United Nations Millennium Development Goals; CHWs, community health workers; EPI, Expanded Program on Immunization; BCG, Bacillus Calmette–Guerin; DTP, diphtheria, tetanus and pertussis; TT, tetanus toxoid vaccine; Gavi, Gavi, the vaccine alliance; ICC, inter-agency coordinating committee; MOH, Ministry of Health of Rwanda; HMIS, Health Management Information System; CRS, congenital rubella syndrome.

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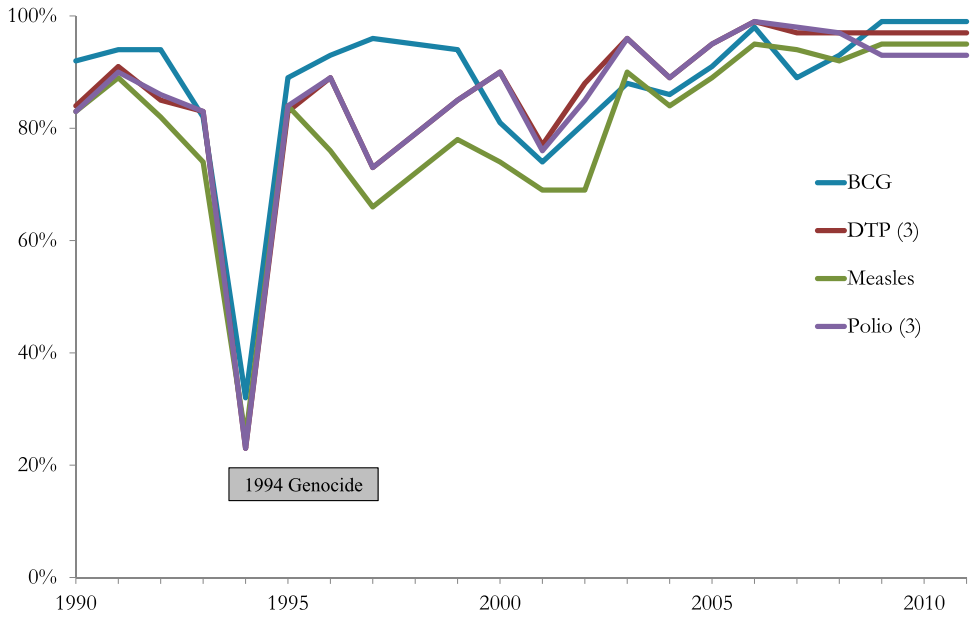


Fig. 1. WHO-recommended vaccination coverage in Rwanda.

After the genocide, few predicted seeing a rebound in Rwanda's health sector for decades to come. Indeed, there were only a handful of health workers in the whole of Rwanda at the time of the genocide [4,5]. The turnaround achieved over the course of the following decades has been a product of strong national ownership, a commitment to equity and evidence-based policy making, collaboration and participation at all levels, and community access to and involvement in health care [6]. Life expectancy more than doubled between 1995 and 2011, while deaths attributable to HIV, tuberculosis, and malaria fell by more than 75% from peak levels [7]. Between 2000 and 2011, Rwanda's child mortality rate dropped 70.4%—more than any other country in the world above 500,000 population [7].

As the pace of vaccine uptake accelerates across Africa and around the world with the support of Gavi, the Vaccine Alliance, and other organizations, there is a need to document low-income countries' experiences in planning and implementation of new vaccine introductions [8]. In the present article, authors describe Rwanda's successive roll-out of four new vaccines between 2009 and 2013: pneumococcal conjugate (PCV) in 2009, human papillomavirus (HPV) in 2011, rotavirus in 2012, and measles–rubella (MR) in 2013. Rwanda was the first country in sub-Saharan Africa to roll out the PCV, HPV, and MR vaccines, and the third Gavi-eligible country in Africa to roll out the rotavirus vaccine [9–12]. Authors describe the national immunization program and share lessons that may be useful to other countries.

2. Immunization program context

In 2011, 625 physicians, 8273 nurses, and 240 midwives served in Rwanda's 5 referral hospitals, 42 district hospitals, and 469 health centers [13]. Of particular relevance to the immunization program, there are approximately 45,000 elected, trained, and equipped community health workers (CHWs) who provide basic health services related to malaria, respiratory infections, diarrhea, and other major childhood killers. Each community elects 3 health workers, two assigned to community health, nutrition, and HIV/AIDS and one assigned to maternal health. Local cooperatives (such as small stores) help to finance the program. All CHWs must have 6 years of education and payment is based upon performance [15]. CHWs are supervised by a coordinator at their local health post who provides information on immunization campaigns [15,16]. CHWs are additionally responsible for referring patients to health centers and hospitals.

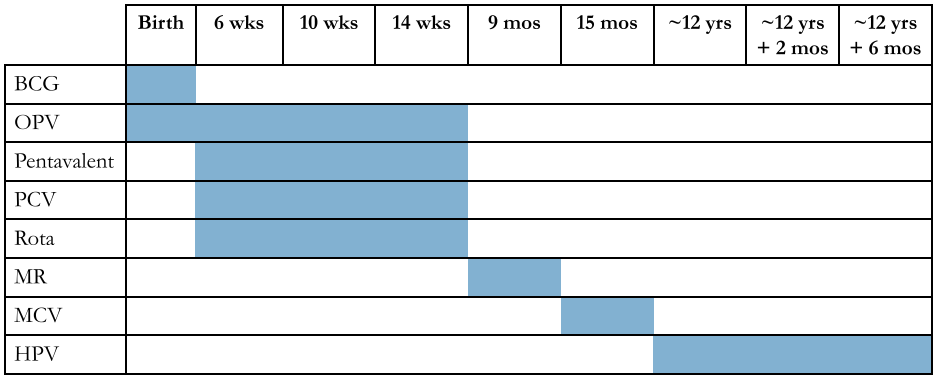
Rwanda's Health Management Information System (HMIS) is a central repository for health data from public and private health facilities used to monitor the burden of disease and intervention coverage, as well as to support decisions regarding vaccine rollout

Rwanda's Expanded Program on Immunization (EPI) was founded in 1978, one year after the World Health Organization's EPI global policies and targets were established. By 1980, Rwanda had introduced three childhood vaccines nationwide: Bacillus Calmette–Guerin (BCG), diphtheria, tetanus and pertussis combination (DTP), and measles, as well as maternal tetanus toxoid (TT) [17]. The rebirth of the national vaccination program after the genocide came in 1996 when an inter-agency coordinating committee (ICC) was formed with development partners; the ICC still manages all national immunizations. The years of introduction and

Table 1
New vaccine introductions in Rwanda.

Vaccine	Date introduced	2013 coverage (%)
BCG	1980	99
DTP3	1980	98
MCV	1980	97
Pol3	1980	98
PAB	1980	85
HepB3	2002	98
Hib3	2002	98
PCV3	2009	98
HPV[a]	2011	97
Rota	2012	99
MR[b]	2013	98

[a,b] WHO does not currently provide data on HPV and MR, so EPI estimates were used. Adapted from: World Health Organization (2013). WHO-UNICEF vaccination coverage estimates time series for Rwanda. **BCG**: Bacillus Calmette-Guérin vaccine, **DTP3**: diphtheria, tetanus and pertussis vaccine 3rd dose, **MCV**: meningococcal vaccine, **Pol3**: oral polio vaccine 3rd dose, **PAB**: 2 doses of tetanus toxoid given to mothers to protect infants at birth, **HepB3**: hepatitis B vaccine 3rd dose, **Hib3**: *Haemophilus Influenzae* type B vaccine 3rd dose, **PCV3**: pneumococcal conjugate vaccine 3rd dose, **HPV**: human papillomavirus vaccine, **Rota**: rotavirus vaccine last dose, **MR**: measles-rubella vaccine http://apps.who.int/immunization_monitoring/globalsummary/estimates?c=RWA and Rwanda Biomedical Center-Vaccine Preventable Diseases Division. Routine Immunization Coverage Evaluation Survey, 2013



BCG: Bacillus Calmette-Guérin vaccine, **OPV**: oral polio vaccine, Pentavalent: diphtheria, tetanus and pertussis, *Haemophilus Influenzae* type B and hepatitis B vaccine, **PCV**: pneumococcal conjugate vaccine, **Rota**: rotavirus vaccine, **MR:** measles-rubella vaccine, **MCV**: meningococcal vaccine, **HPV:** human papillomavirus vaccine

Fig. 2. Vaccine schedule for children in Rwanda.

coverage rates for the 11 vaccines now included in Rwanda's EPI are presented in Table 1 [3]. Disease burden, vaccine availability, cost-analysis, cold chain capacity and safety and efficacy were the major factors considered prior to each immunization rollout.

3. Pneumococcal conjugate vaccine introduction

In 2007, the WHO added PCV to its list of recommended routine childhood immunizations to combat *Streptococcous pneumoniae*, then responsible for approximately one million child deaths each year worldwide [18]. Following this recommendation, a technical committee comprised of Ministry of Health policymakers and advisors from Gavi and the WHO investigated the feasibility of PCV rollout in Rwanda. HMIS data revealed that pneumonia was the leading cause of death among children under five. Cerebrospinal fluid samples taken from suspected meningitis cases at Rwanda's two main public referral hospitals showed that *S. pneumoniae* was the prevailing cause of bacterial meningitis [19]. In the absence of additional national data, the high regional and global burden were taken into account [20]. The Ministry of Finance was involved in determining the country's ability to fund the rollout. Cold chain capacity was determined to be sufficient for rollout, and safety and efficacy profiles were reviewed. In April 2009, Rwanda became the first low-income country to roll out the vaccine nationwide [21]. Funding for the vaccine introduction came from Gavi, while the Ministry of Health financed transportation, training, sensitization, and monitoring. NGOs and private donors also provided financial support.

A countrywide evaluation of cold chain and storage capacity in 2007 had prompted the Ministry to lease new storage space for consumables and to have an extra cold room and several new incinerators built. A two-pronged need estimation method that compared data gathered by CHWs who counted children under one-year in their catchment areas with UNICEF projections helped to prevent stock-outs during rollout [19]. This method would be used in subsequent rollouts of the HPV, rotavirus, and MR vaccines. Finally, the MOH analyzed supply chain dynamics during the PCV rollout to provide information for future vaccine rollouts.

Specialized training was provided to all health workers involved in vaccine handling and delivery, and covered immunization technology, vaccine management, equipment maintenance, injection safety, disposal of waste, supervision, monitoring adverse events, and communication. Instructors also took this opportunity to boost the overall immunization expertise of health workers in areas of weakness identified during supervisory visits undertaken in years prior. With more than 80% of Rwanda's population living in rural areas in 2007, the decentralization of messaging and of medical and technical capacity was vital to ensuring equitable distribution of resources nationwide. Trainings of trainers and micro-planning workshops were held in all districts. In order to encourage acceptance of the new vaccine, awareness days were held for local authorities, teachers, traditional healers, religious leaders and community-based non-governmental organizations. A media campaign encouraging vaccination was conducted, including outreach via newspapers, radio, and television, and at community meetings. Community health workers were taught the risks and benefits of vaccinations and disseminated this information to their communities [19]. Additionally, residents were asked by their community health workers whether their children were vaccinated to ensure that particular locations did not require additional vaccination days.

Implementation of the PCV program was done sequentially by province to ensure quality, central oversight, and to allow for lessons to translate from one community to another. The MOH established outreach vaccination sites in remote areas using motorcycles and cold boxes for transport. The vaccine was available nationwide within five months of the start date. Coverage for all three doses of PCV in the inaugural year of rollout in 2009 reached 97% of recipients expected by UNICEF population projections; in the subsequent 3 years, coverage increased to 98% [3]. This high coverage suggested that the delivery system was sufficiently robust to consider rollout of future vaccinations. PCV is now included in Rwanda's routine immunization schedule, and monthly monitoring and evaluation is coordinated at the central level (Fig. 2).

In addition to routine PCV immunization, community health workers are able to provide antibiotics to treat pneumonia in accordance with the Ministry's emphasis on integrated care [15]. The Vaccine Preventable Diseases Division and the Maternal and Child Health branch of the MOH offer PCV immunization every six months during Maternal and Child Health weeks. Missed doses can be given during these weeks or when children present at health posts due to illness.

Importantly, in 2011, Rwanda switched from using PCV-7 vaccine to PCV-13, a newly available formulation that protects against infection caused by six additional strains of the bacteria. The PCV-13 uses syringes that require a lower incineration temperature compared to the pre-filled syringes previously used for PCV-7. PCV-13 also requires less cold storage space, which made room for the HPV vaccine to be added without significant expansion of infrastructure.

4. Human papillomavirus vaccine introduction

In 2010, the WHO reported that cervical cancer was the leading cause of cancer deaths among Rwandan women, responsible for nearly 700 deaths each year. [23]. Given this information and a desire to improve women's health, the First Lady of Rwanda began to advocate for a national HPV immunization program. Her advocacy ultimately led to discussions between the Rwandan Ministry of Health and Merck. In the absence of extensive national data, the Ministry of Health took into account the high regional and global data burdens of cervical cancer [23,24]. The government simultaneously assessed financial viability and sustainability, and country ownership. Discussion ultimately culminated in a visit by leadership from Merck to Rwanda to conduct a series of assessments. In accordance with the WHO-UNICEF Joint Statement on Vaccine Donations [25], an agreement was reached: Merck would provide a 3-year donation of quadrivalent HPV vaccine sufficient to cover demand beginning in 2011, with concessional pricing after 2013 [26]. Merck's generosity and partnership made HPV vaccine rollout feasible in Rwanda.

Thus, the high burden of HPV infection and cervical cancer in Rwanda, Merck's donation, the WHO's conditional recommendation supporting rollout [27], and the nearly 100% effectiveness of the vaccine against the most oncogenic strains of HPV compelled the government to action.

An HPV vaccination working group was convened and included representatives from the Ministry of Education, Ministry of Gender and Family Promotion, Ministry of Local Government and the Center for Treatment and Research on AIDS, Tuberculosis, Malaria and other Epidemics as well as health workers involved in cancer care. These groups determined the method for identification of girls in and out of school, procurement and distribution logistics, as well as the content and organization of education and sensitization campaigns [23]. The technical working group drew on lessons learned through the PCV campaign, especially concerning outreach, methods to estimate target population size, and infrastructure investments. As with PCV, strategic planning started two years before rollout. With the change to the more compact PCV-13 for PCV-7 formulation in 2011, a full assessment of the cold chain determined that the amount of new cold space required was minimal.

Through focus groups with local leaders, community health workers and teachers, the Ministry of Health undertook a situational analysis of knowledge, attitudes, and beliefs surrounding HPV vaccination. A widespread outreach campaign commenced on radio and television, including speeches by senior public officials.

In March 2011, Rwanda became the first low-income country in the world to launch a national HPV vaccine program. Policymakers felt that a school-based approach would improve coverage rates because 98% of Rwandan girls attend primary school. During the rollout, girls in grade 6 received a full 3-dose course of the vaccine. In 2012 and 2013, a "catch-up" phase for girls in the 3rd year of secondary school was carried out to ensure complete coverage of the targeted age groups. Girls in Grade 6 were chosen because the majority are not yet sexually active but are old enough to receive sexual education [23]. Rwanda's community health workers actively sought out girls who were not in school during the three vaccination days each year. School based vaccination helped in achieving high coverage because the girls did not need to travel to health facilities in order to receive vaccination. Following the 3-year evaluation in 2014, the government transitioned to immunizing 12 year-old girls rather than using a grade-based strategy. Due to coordination and efforts of the government and partners, Rwanda achieved 93.2% coverage among all eligible girls for all 3 doses in 2011 [23], followed by 96.6% coverage in 2012 [29].

During the first year of Rwanda's program, some international observers expressed concern about the cost-effectiveness and sustainability of HPV vaccination in sub-Saharan Africa [30,31]. In the midst of Rwanda's first year of rollout, vaccine manufacturers reduced their lowest price per dose from $15 to $5 (USD). Further reductions have occurred since [32], and these prices have been applied to all Gavi-eligible countries. Additionally, the cost and ease of a full course of vaccination is expected to decrease with the announcement by the World Health Organization that three doses are no longer necessary for girls under 15 years of age, and that a two-dose course of the vaccine is now adequate [33].

5. Rotavirus vaccine rollout

Globally, rotavirus causes 37% of childhood deaths caused by diarrhea, and 5% of all deaths in children younger than 5 years [34]. A review of HMIS data from 2008 showed that diarrhea was the third leading cause of death among children under five in Rwanda [17]. Given this high burden and following the announcement of Gavi funding for rotavirus, a technical committee was assembled to determine the feasibility rotavirus vaccine rollout. The laboratory at the University Teaching Hospital of Kigali found that 30% of pediatric patients' stool samples brought in between December 2010 and April 2011 tested positive for rotavirus [17]. Following a cost analysis, and given the high prevalence of severe diarrheal disease caused by rotavirus, as well as the WHO recommendation that rotavirus vaccines be included in all national immunization programs [35], Rwanda's Ministry of Health decided to begin delivery of the rotavirus vaccine in May 2012. The rotavirus rollout was funded by an introduction grant from Gavi, with the remaining costs covered by the Government of Rwanda.

Rwanda engaged in a detailed cold storage assessment as performed prior to the PCV and HPV rollouts. Refrigerators, cold boxes, and vaccine carriers were ordered to meet the need for additional cold storage requirements at district hospitals and health centers.

As had been done in preparation for the PCV rollout, a train-the-trainers strategy was employed to disseminate guidelines and best practices regarding rotavirus vaccine delivery. During training, tests of vaccine quality and care of the stock were emphasized to reduce vaccine loss. Community volunteers in each health facility were also recruited and trained to promote community understanding regarding the benefits of rotavirus vaccination. Specific timelines were developed for rollout at each health center as recommended by the post-rollout evaluation of the PCV campaign. As with the HPV campaign, focus groups were assembled to develop effective messaging strategies, which were pre-tested prior to distribution.

Between May and November 2012, Rwanda achieved three-dose coverage of 93% among children under 1 year of age [36]. Rotavirus vaccination campaigns in Mexico and South Africa have been successful in reducing child deaths and hospitalizations due to diarrhea; it is likely that Rwanda will see similar decreased deaths [37,38]. Finally, in conjunction with the rotavirus vaccine rollout, Rwanda has enhanced training for community health workers to provide oral rehydration therapy and zinc to children with diarrhea, further preventing deaths.

6. MR vaccine rollout

Following Gavi's announcement of co-financing for measles and rubella vaccine in 2012, Rwanda established a technical committee to consider rollout. Routine surveillance in Rwanda identified over 30 cases of rubella per year between 2008 and 2011 [39]. Rubella infection in pregnant women can cause spontaneous abortion of the fetus or congenital rubella syndrome (CRS), which can lead to

deafness, congenital heart defects, mental retardation, cataracts and death [40]. Approximately 110,000 CRS cases occur each year in developing countries [41].

Measles vaccination was already part of routine immunization in Rwanda. Vaccination coverage rates for the initial one-dose measles vaccine exceeded 80% between 2003 and 2010, yet routine surveillance identified 121 cases of measles in 2010 in Rwanda. This was an important factor in the decision to rollout measles and rubella combined vaccine [39]. Furthermore, the WHO recommended all children receive a second dose of measles vaccine before 5 years of age after the first dose at 9 to 15 months of age [42]. Thus, the option of a combined measles rubella (MR) vaccine meant providing a second ("booster") dose of measles vaccine concurrent with the introduction of the rubella vaccination [43].

Following an analysis of the cost of rollout and cold chain capacity, an application was submitted to Gavi, which agreed to co-finance Rwanda's launch of the MR vaccine in March 2013. Gavi provided funding for the vaccines and consumables (including syringes and safety boxes) and operational costs for the first campaign [12]; the government contributed 20% of the cost. To facilitate the integration of the vaccine into the routine EPI schedule, Gavi provided a cash grant of $0.80 per child for one year.

The MOH leased a new cold room from UNICEF and purchased and distributed refrigerators and vaccine carriers to health centers throughout Rwanda. A micro-planning workshop was conducted at the national level with 42 district hospital representatives prior to rollout. Training of trainers was implemented in the aforementioned cascade method and included district health workers, community health workers, teachers, and volunteers. Technical assistance in planning and monitoring was provided by UNICEF, WHO, and the US Centers for Disease Control [39].

The MOH informed all district mayors about the campaign and encouraged contact with local educational institutions. Banners, radio announcements, television, and newspapers were all used for sensitization. CHWs informed the population about the vaccination campaign during monthly community service ("Umuganda") meetings. Teachers were notified and encouraged to communicate with parents and students directly about the nature of the campaign.

Beginning in March 2013, the MOH launched the catch-up campaign targeting an estimated five million children between 9 months and 15 years of age. Vaccination sites included 4214 schools, 2247 community sites and transit vaccination posts at bordering districts, and 453 health centers. Household surveys were carried out during the campaign to identify regions of low coverage. In districts where coverage was low, it appeared that there was reduced involvement of community health workers in social mobilization [43]. MR coverage was estimated at 93%, 89%, and 110% for children between 9–11 months, 1–4 years, and 5–15 years (more children than anticipated by demographic projections were in need of the vaccine) [43].

The rollout of the MR vaccine was deliberately planned to occur during Rwanda's Child and Adolescent Health Week in order to integrate several interventions. In 2013, girls in Primary Grade 6 and Secondary Grade 3 received their third dose of HPV vaccine during the same time that MR was provided to infants; children between the ages of 9 and 15 months also received an oral dose of vitamin A. This approach of coupling vaccination with large-scale vitamin A administration was recommended by the WHO for use during polio eradication campaigns, because such campaigns provide access to such a large proportion of children under 5, and because the same health workers can deliver these interventions to the child in rapid succession [46]. Postpartum mothers also received vitamin A supplementation during these campaigns. By integrating MR vaccination, HPV vaccination and vitamin A administration, the government was able to deploy healthcare workers more efficiently and enable the public to receive as many interventions as possible with decreased disruption to their lives [47]. Given these benefits, other countries may consider similar methods of integration during vaccination rollouts.

7. Lessons learned

Multiple lessons can be drawn from Rwanda's experience rolling out four new vaccines within five years (Table 2). First, a strong health care system is needed to ensure access to vaccination and a sufficient number of health workers trained to deliver vaccines. Additionally, a high level of political will is needed, as evidenced by the Rwandan First Lady's championing of the HPV vaccine and governmental emphasis on child health. Advance planning and effective training is essential prior to rollout. By engaging in focus groups, organizing micro-planning workshops, conducting detailed cold chain analyses and initiating planning at least a year in advance, the government of Rwanda was able to minimize complications during rollout and prevent stock-outs. Furthermore, the use of the ICC allowed for different sectors of government to collaborate and share their expertise during rollout. The use of the ICC has allowed Rwanda to invest in the education of government personnel around immunization planning and empowers them to participate directly in decision-making.

Community ownership and participation were also essential. By notifying local leaders, teachers, community health workers and the general population and tailoring messages to each group, the MOH was able to produce a high turnout on vaccination days. Partnerships with the private sector, local NGOs and donors within the framework of accountability and country ownership enabled the MOH to receive guidance and support while allowing for coordinated rollouts throughout the country. The transparent, careful use of donor funds promoted continued support for each successive campaign. Routine monitoring and evaluation allowed for progressive improvements.

The introduction of new vaccines is necessarily accompanied by opportunities to correct errors and improve programs. Several problems arose over the course of the five years. For example, the initial MR vaccine campaign was planned to take place over four days; however, it was extended for an additional day in Kigali due to the identification of additional nursery schools that were missed during micro-planning. The campaign was also extended in one district due to low coverage discovered through household surveys.

Taking actions based on robust and cross-checked evidence, prioritizing equitable access to essential immunizations based on

Table 2
Summary of lessons learned.

High level of government commitment
• Negotiation with pharmaceutical companies
• Involvement of diverse sectors of government in planning
Advance planning
• Preparation beginning at least one year in advance of rollout
• Procurement of sufficient cold storage and equipment
• Use of community health workers to determine size of target population to prevent stockouts
Engaged community health workers
• Active case finding of those not vaccinated for HPV
• Useful for educating population and encouraging of-age children's attendance at vaccination days
Community engagement
• Outreach to teachers, politicians and news media
• Use of community meetings to deliver information about vaccination and encourage turnout during campaigns
• Decentralization of vaccine delivery
Continual evaluation
• Monitoring of challenges during each campaign
• Use of information in trainings from previous campaigns

community-driven campaigns, and a nimble team of authorities at all levels to coordinate and integrate vaccination campaigns led to near-universal coverage rates. Further reductions in child mortality in Rwanda are anticipated following the new vaccines' rollout, as observed in South Africa and Mexico following rotavirus vaccine administration [37,38]. Rwanda's 2015 Demographic and Health Survey reported continued declines in child mortality, from 76 to 50 deaths per 1000 live births between 2010 and 2015, likely attributable in part to recent vaccine introductions and sustained rates of high coverage. [48].

In low-income countries, lack of health care infrastructure, constraints imposed by lack of funding, and the belief that patents make the vaccines too expensive for discussing access are seen as barriers to vaccine rollout [49]. By harnessing political will, carefully planning for campaigns, engaging with local communities, and mobilizing decentralized teams, Rwanda's vaccination program has illustrated that each of these barriers can be overcome. National policymakers and global health funding agencies should draw on the latest and strongest evidence from the basic sciences and from health economics; the pursuit of health equity must also play a central role in decisions about disease control priorities. Notions of cost-effectiveness may rely too much on fixed inputs for dynamic variables: as the HPV vaccine shows, prices can fall precipitously in short amounts of time with the right approaches to partnership. In 2000, the Government of Rwanda developed the Vision 2020 plan, which aims to make Rwanda a middle-income country by 2020 through investments in education, good governance, openness to business and a focus on infrastructure development. Rwanda's progress toward fulfilling this goal may eventually allow the country to graduate from Gavi subsidies and to support its own vaccination programs [50]. It is our hope that lessons learned through Rwanda's successive rollouts of the PCV, HPV, rotavirus, and MR vaccines may be useful to other countries considering expansion of their national immunization programs, because every child deserves access to these lifesaving vaccines.

Contributors

MG was responsible for the article's conception. All authors were involved in the acquisition and interpretation of data. MG, SB, CMW, CTN, and AB drafted the manuscript. All authors provided critical revisions.

Conflicts of interest statement

None.

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