

# VACCINE DELIVERY RESEARCH DIGEST

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UNIVERSITY OF WASHINGTON GLOBAL HEALTH START PROGRAM  
REPORT TO THE BILL AND MELINDA GATES FOUNDATION

APRIL 1, 2014



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## 1. VACCINE PREVENTABLE DISEASES: TIME TO RE-EXAMINE GLOBAL SURVEILLANCE DATA?

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Macneil A, Dietz V, Cherian T.

Vaccine. 2014 Mar 10. pii: S0264-410X(14)00278-3. doi: 10.1016/j.vaccine.2014.02.067. [Epub ahead of print]

PMID: 24625342 [PubMed - as supplied by publisher]

### ABSTRACT

While data driven estimates of the global burden of disease for some vaccine preventable diseases (VPDs) are limited, aggregate case numbers of VPDs are reported annually by country in the Joint Reporting Form (JRF). We examined pertussis surveillance data in the JRF, and vaccine coverage estimates, in comparison to measles, which is a priority disease for elimination and eradication efforts and is supported by the WHO Global Measles and Rubella Laboratory Network. In 2012, highest pertussis case numbers and incidence were reported from high income countries with high vaccine coverage, discordant with countries that had low vaccine coverage. Use of laboratory diagnostics for pertussis cases varied among countries. In contrast, highest reported numbers of measles cases and incidences tended to occur in low income countries. These observations imply poor quality global surveillance data for some VPDs, limiting capacity for monitoring global epidemiology or making vaccination policy decisions. Efforts are needed to improve the availability of quality surveillance data for all VPDs.

**WEB:** <http://www.sciencedirect.com/science/article/pii/S0264410X14002783>

**IMPACT FACTOR:** 3.49

**CITED HALF-LIFE:** 4.90

**UW EDITORIAL COMMENT:** A secondary analysis of existing surveillance data. Figures 1 & 2, scatter plots of the reported incidence of each disease compared to estimated vaccine coverage and Gross National Income per capita, are highly informative summaries. Their findings highlight the inability of current surveillance systems to accurately assess vaccination program performance in some resource-limited settings.



## 2. BENEFITS OF USING VACCINES OUT OF THE COLD CHAIN: DELIVERING MENINGITIS A VACCINE IN A CONTROLLED TEMPERATURE CHAIN DURING THE MASS IMMUNIZATION CAMPAIGN IN BENIN.

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Zipursky S, Djingarey MH, Lodjo JC, Olodo L, Tiendrebeogo S, Ronveaux O.

Vaccine. 2014 Mar 14;32(13):1431-5. doi: 10.1016/j.vaccine.2014.01.038. Epub 2014 Feb 19.

PMID: 24559895 [PubMed - in process]

### ABSTRACT

**BACKGROUND:** In October 2012, the Meningococcal A conjugate vaccine MenAfriVac was granted a label variation to allow for its use in a controlled temperature chain (CTC), at temperatures of up to 40°C for not more than four days. This paper describes the first field use of MenAfriVac in a CTC during a campaign in Benin, December 2012, and assesses the feasibility and acceptability of the practice.

**METHODS:** We implemented CTC in one selected district, Banikoara (target population of 147,207; 1-29 years of age), across 14 health facilities and 150 villages. We monitored the CTC practice using temperature indicators and daily monitoring sheets. At the end of the campaign we conducted a face-to-face survey to assess vaccinators' and supervisors' experience with CTC.

**FINDINGS:** A mix of strategies were implemented in the field to maximize the benefits from CTC practice, depending on the distance from health centre to populations and the availability of a functioning refrigerator in the health centre. Coverage across Banikoara was 105.7%. Over the course of the campaign only nine out of approx. 15,000 vials were discarded due to surpassing the 4 day CTC limit and no vial was discarded because of exposure to a temperature higher than 40°C or due to the Vaccine Vial Monitor (VVM) reaching its endpoint. Overall confidence and perceived usefulness of the CTC approach were very high among vaccinators and supervisors.

**INTERPRETATION:** Vaccinators and supervisors see clear benefits from the CTC approach in low income settings, especially in hard-to-reach areas or where cold chain is weak. Taking advantage of the flexibility offered by CTC opens the door for the implementation of new immunization strategies to ensure all those at risk are protected.

**WEB:** <http://www.sciencedirect.com/science/article/pii/S0264410X14000723>

**IMPACT FACTOR:** 3.49

**CITED HALF-LIFE:** 4.90

### UW EDITORIAL COMMENT:

This article documents the potential utility of CTC in some mass immunization campaigns. Since the authors did not describe their participant selection criteria, the study may be limited by potential respondent selection bias. In addition, relatively few supervisors were surveyed (n=21), giving rise to wide confidence intervals for the percentages given in Tables 1, 2, 3, 4.



### 3. DISTANCE TO HEALTH SERVICES AFFECTS LOCAL-LEVEL VACCINE EFFICACY FOR PNEUMOCOCCAL CONJUGATE VACCINE (PCV) AMONG RURAL FILIPINO CHILDREN.

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Root ED, Lucero M, Nohynek H, Anthamatten P, Thomas DS, Tallo V, Tanskanen A, Quiambao BP, Puumalainen T, Lupisan SP, Ruutu P, Ladesma E, Williams GM, Riley I, Simões EA.

Proc Natl Acad Sci U S A. 2014 Mar 4;111(9):3520-5. doi: 10.1073/pnas.1313748111. Epub 2014 Feb 18. PMID: 24550454 [PubMed - in process]

#### ABSTRACT

Pneumococcal conjugate vaccines (PCVs) have demonstrated efficacy against childhood pneumococcal disease in several regions globally. We demonstrate how spatial epidemiological analysis of a PCV trial can assist in developing vaccination strategies that target specific geographic subpopulations at greater risk for pneumococcal pneumonia. We conducted a secondary analysis of a randomized, placebo-controlled, double-blind vaccine trial that examined the efficacy of an 11-valent PCV among children less than 2 y of age in Bohol, Philippines. Trial data were linked to the residential location of each participant using a geographic information system. We use spatial interpolation methods to create smoothed surface maps of vaccination rates and local-level vaccine efficacy across the study area. We then measure the relationship between distance to the main study hospital and local-level vaccine efficacy, controlling for ecological factors, using spatial autoregressive models with spatial autoregressive disturbances. We find a significant amount of spatial variation in vaccination rates across the study area. For the primary study endpoint vaccine efficacy increased with distance from the main study hospital from -14% for children living less than 1.5 km from Bohol Regional Hospital (BRH) to 55% for children living greater than 8.5 km from BRH. Spatial regression models indicated that after adjustment for ecological factors, distance to the main study hospital was positively related to vaccine efficacy, increasing at a rate of 4.5% per kilometer distance. Because areas with poor access to care have significantly higher VE, targeted vaccination of children in these areas might allow for a more effective implementation of global programs.

**WEB:** <http://www.pnas.org/content/111/9/3520.long>

**IMPACT FACTOR:** 9.74

**CITED HALF-LIFE:** 8.00

**UW EDITORIAL COMMENT:** Vaccine efficacy, as measured by radiographic pneumonia, appeared to show a readily visible spatial pattern (Figure 2 A). However, the spatial variation of vaccination rates did not appear to have a discernible pattern (Figure 1 A,B).



#### 4. KNOWLEDGE AND AWARENESS OF HPV VACCINE AND ACCEPTABILITY TO VACCINATE IN SUB-SAHARAN AFRICA: A SYSTEMATIC REVIEW.

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Perlman S, Wamai RG, Bain PA, Welty T, Welty E, Ogembo JG.

PLoS One. 2014 Mar 11;9(3):e90912. doi: 10.1371/journal.pone.0090912. eCollection 2014.

PMID: 24618636 [PubMed - in process] PMCID: PMC3949716

#### ABSTRACT

**OBJECTIVES:** We assessed the knowledge and awareness of cervical cancer, HPV and HPV vaccine, and willingness and acceptability to vaccinate in sub-Saharan African (SSA) countries. We further identified countries that fulfill the two GAVI Alliance eligibility criteria to support nationwide HPV vaccination.

**METHODS:** We conducted a systematic review of peer-reviewed studies on the knowledge and awareness of cervical cancer, HPV and HPV vaccine, and willingness and acceptability to vaccinate. Trends in Diphtheria-tetanus-pertussis (DTP3) vaccine coverage in SSA countries from 1990-2011 were extracted from the World Health Organization database.

**FINDINGS:** The review revealed high levels of willingness and acceptability of HPV vaccine but low levels of knowledge and awareness of cervical cancer, HPV or HPV vaccine. We identified only six countries to have met the two GAVI Alliance requirements for supporting introduction of HPV vaccine: 1) the ability to deliver multi-dose vaccines for no less than 50% of the target vaccination cohort in an average size district, and 2) achieving over 70% coverage of DTP3 vaccine nationally. From 2008 through 2011 all SSA countries, with the exception of Mauritania and Nigeria, have reached or maintained DTP3 coverage at 70% or above.

**CONCLUSION:** There is an urgent need for more education to inform the public about HPV, HPV vaccine, and cervical cancer, particularly to key demographics, (adolescents, parents and healthcare professionals), to leverage high levels of willingness and acceptability of HPV vaccine towards successful implementation of HPV vaccination programs. There is unpreparedness in most SSA countries to roll out national HPV vaccination as per the GAVI Alliance eligibility criteria for supporting introduction of the vaccine. In countries that have met 70% DTP3 coverage, pilot programs need to be rolled out to identify the best practice and strategies for delivering HPV vaccines to adolescents and also to qualify for GAVI Alliance support.

**WEB:** <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0090912>

**IMPACT FACTOR:** 3.73

**CITED HALF-LIFE:** 2.4

**UW EDITORIAL COMMENT:** This paper followed a thorough, clearly described systematic review process and highlights key gaps in targeting adolescents for HPV vaccination.



## 5. DRIVERS OF ROUTINE IMMUNIZATION COVERAGE IMPROVEMENT IN AFRICA: FINDINGS FROM DISTRICT-LEVEL CASE STUDIES.

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Lafond A, Kanagat N, Steinglass R, Fields R, Sequeira J, Mookherji S.

Health Policy Plan. 2014 Mar 10. [Epub ahead of print]

PMID: 24615431 [PubMed - as supplied by publisher]

### ABSTRACT

There is limited understanding of why routine immunization (RI) coverage improves in some settings in Africa and not in others. Using a grounded theory approach, we conducted in-depth case studies to understand pathways to coverage improvement by comparing immunization programme experience in 12 districts in three countries (Ethiopia, Cameroon and Ghana). Drawing on positive deviance or assets model techniques we compared the experience of districts where diphtheria-tetanus-pertussis (DTP3)/pentavalent3 (Penta3) coverage improved with districts where DTP3/Penta3 coverage remained unchanged (or steady) over the same period, focusing on basic readiness to deliver immunization services and drivers of coverage improvement. The results informed a model for immunization coverage improvement that emphasizes the dynamics of immunization systems at district level. In all districts, whether improving or steady, we found that a set of basic RI system resources were in place from 2006 to 2010 and did not observe major differences in infrastructure. We found that the differences in coverage trends were due to factors other than basic RI system capacity or service readiness. We identified six common drivers of RI coverage performance improvement-four direct drivers and two enabling drivers-that were present in well-performing districts and weaker or absent in steady coverage districts, and map the pathways from driver to improved supply, demand and coverage. Findings emphasize the critical role of implementation strategies and the need for locally skilled managers that are capable of tailoring strategies to specific settings and community needs. The case studies are unique in their focus on the positive drivers of change and the identification of pathways to coverage improvement, an approach that should be considered in future studies and routine assessments of district-level immunization system performance.

**WEB:** <http://heapol.oxfordjournals.org/cgi/pmidlookup?view=long&pmid=24615431>

**IMPACT FACTOR:** 3.06

**CITED HALF-LIFE:** 7.20

**UW EDITORIAL COMMENT:** This study identified several common drivers of routine immunization that could serve as potential targets for future intervention-based studies to improve routine immunization coverage. The study was observational and district selection within target countries was not randomized, potentially leading to selection bias. In addition, informant selection criteria were not provided.



## 6. LOCAL DISCREPANCIES IN MEASLES VACCINATION OPPORTUNITIES: RESULTS OF POPULATION-BASED SURVEYS IN SUB-SAHARAN AFRICA.

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Grout L, Conan N, Juan Giner A, Hurtado N, Fermon F, N'goran A, Grellety E, Minetti A, Porten K, Grais R. BMC Public Health. 2014 Feb 21;14(1):193. doi: 10.1186/1471-2458-14-193. PMID: 24559281 [PubMed - in process] PMCID: PMC3938072

### ABSTRACT

**BACKGROUND:** The World Health Organization recommends African children receive two doses of measles containing vaccine (MCV) through routine programs or supplemental immunization activities (SIA). Moreover, children have an additional opportunity to receive MCV through outbreak response immunization (ORI) mass campaigns in certain contexts. Here, we present the results of MCV coverage by dose estimated through surveys conducted after outbreak response in diverse settings in Sub-Saharan Africa.

**METHODS:** We included 24 household-based surveys conducted in six countries after a non-selective mass vaccination campaign. In the majority (22/24), the survey sample was selected using probability proportional to size cluster-based sampling. Others used Lot Quality Assurance Sampling.

**RESULTS:** In total, data were collected on 60,895 children from 2005 to 2011. Routine coverage varied between countries (>95% in Malawi and Kirundo province (Burundi) while <35% in N'Djamena (Chad) in 2005), within a country and over time. SIA coverage was <75% in most settings. ORI coverage ranged from >95% in Malawi to 71.4% [95% CI: 68.9-73.8] in N'Djamena (Chad) in 2005. In five sites, >5% of children remained unvaccinated after several opportunities. Conversely, in Malawi and DRC, over half of the children eligible for the last SIA received a third dose of MCV.

**CONCLUSIONS:** Control pre-elimination targets were still not reached, contributing to the occurrence of repeated measles outbreak in the Sub-Saharan African countries reported here. Although children receiving a dose of MCV through outbreak response benefit from the intervention, ensuring that programs effectively target hard to reach children remains the cornerstone of measles control.

**WEB:** <http://www.biomedcentral.com/1471-2458/14/193>

**IMPACT FACTOR:** 2.08

**CITED HALF-LIFE:** 3.60

**UW EDITORIAL COMMENT:** The individual studies were large, ranging from 942 to 6,622 children each. In contexts with limited or dated census and vital records data, surveys like these may provide the best estimates of vaccination coverage.





## 7. TREND IN PROPORTIONS OF MISSED CHILDREN DURING POLIO SUPPLEMENTARY IMMUNIZATION ACTIVITIES IN THE AFRICAN REGION: EVIDENCE FROM INDEPENDENT MONITORING DATA 2010-2012.

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Okeibunor J, Gasasira A, Mihigo R, Salla M, Poy A, Orkeh G, Shaba K, Nshimirimana D.

Vaccine. 2014 Feb 19;32(9):1067-71. doi: 10.1016/j.vaccine.2013.12.041. Epub 2014 Jan 14.

PMID: 24434046 [PubMed - in process]

### ABSTRACT

This is a comparative analysis of independent monitoring data collected between 2010 and 2012, following the implementation of supplementary immunization activities (SIAs) in countries in the three sub regional blocs of World Health Organization in the African Region. The sub regional blocs are Central Africa, West Africa, East and Southern Africa. In addition to the support for SIAs, the Central and West African blocs, threatened with importation and re-establishment of polio transmission received intensive coordination through weekly teleconferences. The later, East and Southern African bloc with low polio threats was not engaged in the intensive coordination through teleconferences. The key indicator of the success of SIAs is the proportion of children missed during SIAs. The results showed that generally there was a decrease in the proportion of children missed during SIAs in the region, from 7.94% in 2010 to 5.95% in 2012. However, the decrease was mainly in the Central and West African blocs. The East and Southern African bloc had countries with as much as 25% missed children. In West Africa and Central Africa, where more coordinated SIAs were conducted, there were progressive and consistent drops, from close to 20-10% at the maximum. At the country and local levels, steps were undertaken to ameliorate situation of low immunization uptake. Wherever an area is observed to have low coverage, local investigations were conducted to understand reasons for low coverage, plans to improve coverage are made and implemented in a coordinated manner. Lessons learned from close monitoring of polio eradication SIAs are will be applied to other campaigns being conducted in the African Region to accelerate control of other vaccine preventable diseases including cerebrospinal meningitis A, measles and yellow fever.

**WEB:** <http://www.sciencedirect.com/science/article/pii/S0264410X13017842>

**IMPACT FACTOR:** 3.49

**CITED HALF-LIFE:** 4.90

**UW EDITORIAL COMMENT:** Though originally designed as a program evaluation, the use of independent monitors and random selection of each locality, village, and household were strengths of the study. The study is important in documenting the decrease in the percentage of children missed during polio supplementary immunization activities between 2010 and 2012 (Figure 1).



## 8. COST AND SUSTAINABILITY OF A SUCCESSFUL PACKAGE OF INTERVENTIONS TO IMPROVE VACCINATION COVERAGE FOR CHILDREN IN URBAN SLUMS OF BANGLADESH.

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Hayford K, Uddin MJ, Koehlmoos TP, Bishai DM.

Vaccine. 2014 Mar 11. pii: S0264-410X(14)00302-8. doi: 10.1016/j.vaccine.2014.02.075. [Epub ahead of print]

PMID: 24631083 [PubMed - as supplied by publisher]

### ABSTRACT

**OBJECTIVE:** To estimate the incremental economic costs and explore satisfaction with a highly effective intervention for improving immunization coverage among slum populations in Dhaka, Bangladesh. A package of interventions based on extended clinic hours, vaccinator training, active surveillance, and community participation was piloted in two slum areas of Dhaka, and resulted in an increase in valid fully immunized children (FIC) from 43% pre-intervention to 99% post-intervention.

**METHODS:** Cost data and stakeholder perspectives were collected January-February 2010 via document review and 10 key stakeholders interviews to estimate the financial and opportunity costs of the intervention, including uncompensated time, training and supervision costs.

**RESULTS:** The total economic cost of the 1-year intervention was \$18,300, comprised of external management and supervision (73%), training (11%), coordination costs (1%), uncompensated staff time and clinic costs (2%), and communications, supplies and other costs (13%). An estimated 874 additional children were correctly and fully immunized due to the intervention, at an average cost of \$20.95 per valid FIC. Key stakeholders ranked extended clinic hours and vaccinator training as the most important components of the intervention. External supervision was viewed as the most important factor for the intervention's success but also the costliest. All stakeholders would like to reinstate the intervention because it was effective, but additional funding would be needed to make the intervention sustainable.

**CONCLUSION:** Targeting slum populations with an intensive immunization intervention was highly effective but would nearly triple the amount spent on immunization per FIC in slum areas. Those committed to increasing vaccination coverage for hard-to-reach children need to be prepared for substantially higher costs to achieve results.

**WEB:** [http://linkinghub.elsevier.com/retrieve/pii/S0264-410X\(14\)00302-8](http://linkinghub.elsevier.com/retrieve/pii/S0264-410X(14)00302-8)

**IMPACT FACTOR:** 3.49

**CITED HALF-LIFE:** 4.90

**UW EDITORIAL COMMENT:** This case study presents data from two “representative” slum areas of Dhaka where a significant attempt was made to account for possible associated costs to best estimate of the average cost per increase in fully immunized children. Although the improvements in coverage reported were dramatic, no “control” slum communities were included for comparison.



## 9. COST-EFFECTIVENESS ANALYSIS OF VACCINATING CHILDREN IN MALAWI WITH RTS,S VACCINES IN COMPARISON WITH LONG-LASTING INSECTICIDE-TREATED NETS.

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Seo MK, Baker P, Ngo KN.

Malar J. 2014 Feb 24;13(1):66. [Epub ahead of print]

PMID: 24564883 [PubMed - as supplied by publisher]

### ABSTRACT

**BACKGROUND:** New RTS,S malaria vaccines may soon be licensed, yet its cost-effectiveness is unknown. Before the widespread introduction of RTS,S vaccines, cost-effectiveness studies are needed to help inform governments in resource-poor settings about how best to prioritize between the new vaccine and existing malaria interventions.

**METHODS:** A Markov model simulated malaria progression in a hypothetical Malawian birth cohort. Parameters were based on published data. Three strategies were compared: no intervention, vaccination at one year, and long-lasting, insecticide-treated nets (LLINs) at birth. Both health service and societal perspectives were explored. Health outcomes were measured in disability-adjusted life years (DALYs) averted and costed in 2012 US\$. Incremental cost-effectiveness ratios (ICERs) were calculated and extensive sensitivity analyses were conducted. Three times GDP per capita (\$1,095) per DALY averted was used for a cost-effectiveness threshold, whilst one times GDP (\$365) was considered 'very cost-effective'.

**RESULTS:** From a societal perspective the vaccine strategy was dominant. It averted 0.11 more DALYs than LLINs and 0.372 more DALYs than the no intervention strategy per person, while costing \$10.04 less than LLINs and \$59.74 less than no intervention. From a health service perspective the vaccine's ICER was \$145.03 per DALY averted, and thus can be considered very cost-effective. The results were robust to changes in all variables except the vaccine and LLINs' duration of efficacy. Vaccines remained cost-effective even at the lowest assumed efficacy levels of 49.6% (mild malaria) and 14.2% (severe malaria), and the highest price of \$15. However, from a societal perspective, if the vaccine duration efficacy was set below 2.69 years or the LLIN duration of efficacy was greater than 4.24 years then LLINs became the more cost-effective strategy.

**CONCLUSION:** The results showed that vaccinating Malawian children with RTS,S vaccines was very cost-effective from both a societal and a health service perspective. This result was robust to changes in most variables, including vaccine price and vaccine efficacy, but was sensitive to the duration of efficacy of the vaccine and LLINs. Given the best evidence currently available, vaccines can be considered as a very cost-effective component of Malawi's future malaria control programmes. However, long-term follow-up studies on both interventions are needed.

**WEB:** <http://www.malariajournal.com/content/13/1/66/abstract>

**IMPACT FACTOR:** 3.40

**CITED HALF-LIFE:** 3.30

**UW EDITORIAL COMMENT:** Although this analysis was based on a hypothetical Malawian birth cohort, the analysis does suggest that RTS,S vaccine may be a cost-effective component of future malaria control efforts.



## 10. AN ANALYSIS OF GOVERNMENT IMMUNIZATION PROGRAM EXPENDITURES IN LOWER AND LOWER MIDDLE INCOME COUNTRIES 2006-12.

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Nader AA, de Quadros C, Politi C, McQuestion M.

Health Policy Plan. 2014 Feb 21. [Epub ahead of print]

PMID: 24561878 [PubMed - as supplied by publisher]

### ABSTRACT

Financing is becoming increasingly important as the cost of immunizing the world's children continues to rise. By 2015, that cost will likely exceed US\$60 per infant as new vaccines are introduced into national immunization programs. In 2006, 51 lower and lower middle income countries reported spending a mean US\$12 per surviving infant on routine immunization. By 2012, the figure had risen to \$20, a 67% increase. This study tests the hypothesis that lower and lower middle income countries will spend more on their routine immunization programs as their economies grow. A panel data regression approach is used. Expenditures reported by governments annually (2006-12) through the World Health Organization/UNICEF Joint Reporting Form are regressed on lagged annual per capita gross national income (GNI), controlling for prevailing mortality levels, immunization program performance, corruption control efforts, geographical region and correct reporting. Results show the expenditures increased with GNI. Expressed as an elasticity, the countries spent approximately \$6.32 on immunization for every \$100 in GNI increase from 2006 to 2012. Projecting forward and assuming continued annual GNI growth rates of 10.65%, countries could be spending \$60 per infant by 2020 if national investment functions increase 4-fold. Given the political will, this result implies countries could fully finance their routine immunization programs without cutting funding for other programs.

**WEB:** <http://heapol.oxfordjournals.org/content/early/2014/02/21/heapol.czu002.long>

**IMPACT FACTOR:** 3.06

**CITED HALF-LIFE:** 7.20

**UW EDITORIAL COMMENT:** These conclusions are based on the assumption that GAVI eligible countries will sustain recent GNI growth rates and will disproportionately increase investments in immunization programs (see Figure 2). The explicit statement of these assumptions will allow others to debate their plausibility and discuss alternative models to predict the ability of and timeline for developing countries to finance their own immunization programs.



## APPENDIX: PUBMED SEARCH TERMS

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(((((vaccine[tiab] OR vaccines[tiab] OR vaccination[tiab] OR immunization[tiab] OR immunisation[tiab] OR vaccine[mesh] OR immunization[mesh]) AND (logistics[tiab] OR supply[tiab] OR "supply chain"[tiab] OR implementation[tiab] OR expenditures[tiab] OR financing[tiab] OR economics[tiab] OR "Cost effectiveness"[tiab] OR coverage[tiab] OR attitudes[tiab] OR belief[tiab] OR beliefs[tiab] OR refusal[tiab] OR "Procurement"[tiab] OR timeliness[tiab] OR systems[tiab])) OR ("vaccine delivery"[tiab])) NOT ("in vitro"[tiab] OR "immune response"[tiab] OR gene[tiab] OR chemistry[tiab] OR genotox\*[tiab] OR sequencing[tiab] OR nanoparticle\*[tiab] OR bacteriophage[tiab] OR exome[tiab] OR exogenous[tiab] OR electropor\*[tiab] OR "systems biology"[tiab] OR "animal model"[tiab] OR cattle[tiab] OR sheep[tiab] OR goat[tiab] OR rat[tiab] OR pig[tiab] OR mice[tiab] OR mouse[tiab] OR murine[tiab] OR porcine[tiab] OR ovine[tiab] OR rodent[tiab] OR fish[tiab])) AND (English[LA]) AND ("2014/02/15"[PDAT] : "2014/03/14"[PDAT]))

\*On March 21, 2014, this search of English language articles published between February 15, 2014 and March 14, 2014 and indexed by the US National Library of Medicine resulted in 176 unique manuscripts.

## GLOSSARY

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**Cited half-life:** The median age of a journal's articles that were cited by other journals in a given year.

**Impact factor:** A metric that quantifies a journal's average number of citations per publication in the preceding two years. Though the method has been heavily critiqued, it is an attempt to objectively measure the relative importance of journals within a particular field.

