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10 Mapping routine measles vaccination in low- and middle-income countries

{Abstract & START Commentary} {Full Article}

- A geostatistical modelling study assessing routine one-dose measles vaccination coverage, trends in geographical inequality, and progress towards global coverage targets in 101 low- and middle-income countries annually from 2000 to 2019.

Appendix

Details of Articles

1. Costs of continuing RTS,S/ASO1$_E$ malaria vaccination in the three malaria vaccine pilot implementation countries.

Baral R, Levin A, Odero C, Pecenka C, Tabu C, Mwendo E, et al.

PLoS One. 2021 Jan 23;16(1):e0244995.
PubMed ID: 33428635

ABSTRACT

BACKGROUND: The RTS,S/ASO1$_E$ malaria vaccine is being piloted in three countries-Ghana, Kenya, and Malawi-as part of a coordinated evaluation led by the World Health Organization, with support from global partners. This study estimates the costs of continuing malaria vaccination upon completion of the pilot evaluation to inform decision-making and planning around potential further use of the vaccine in pilot areas.

METHODS: We used an activity-based costing approach to estimate the incremental costs of continuing to deliver four doses of RTS,S/ASO1$_E$ through the existing Expanded Program on Immunization platform, from each government's perspective. The RTS,S/ASO1$_E$ pilot introduction plans were reviewed and adapted to identify activities for costing. Key informant interviews with representatives from Ministries of Health (MOH) were conducted to inform the activities, resource requirements, and assumptions that, in turn, inform the analysis. Both financial and economic costs per dose, cost of delivery per dose, and cost per fully vaccinated child (FVC) are estimated and reported in 2017 USD units.

RESULTS: At a vaccine price of $5 per dose and assuming the vaccine is donor-funded, our estimated incremental financial costs range from $1.70 (Kenya) to $2.44 (Malawi) per dose, $0.23 (Malawi) to $0.71 (Kenya) per dose delivered (excluding procurement add-on costs), and $11.50 (Ghana) to $13.69 (Malawi) per FVC. Estimates of economic costs per dose are between three and five times higher than financial costs. Variations in activities used for costing, procurement add-on costs, unit costs of per diems, and allowances contributed to differences in cost estimates across countries.

CONCLUSION: Cost estimates in this analysis are meant to inform country decision-makers as they face the question of whether to continue malaria vaccination, should the intervention receive a positive recommendation for broader use. Additionally, important cost drivers for vaccine delivery are

highlighted, some of which might be influenced by global and country-specific financing and existing procurement mechanisms. This analysis also adds to the evidence available on vaccine delivery costs for products delivered outside the standard immunization schedule.

WEB: 10.1371/journal.pone.0244995
IMPACT FACTOR: 2.740
CITED HALF-LIFE: 5.6

START COMMENTARY

In this costing analysis, Baral *et al.* use an activity-based costing approach and key informant interviews to estimate the financial and economic incremental costs of four-dose RTS,S/ASO1$_E$ malaria vaccine implementation in Ghana, Kenya, and Malawi from each government's perspective. The authors estimate costs for a seven-year time frame (2020–2026), assessing different levels of government financing of direct vaccine-related costs (0%, 50%, and 100%) within two vaccine implementation scenarios: 1) continuing to vaccinate children within the implementation areas after the pilot vaccination ends, and 2) introducing the vaccine in comparison areas while continuing to vaccinate children within implementation areas. Costs are presented in 2017 USD and include vaccine procurement, microplanning, training, communications, social mobilization, cold chain expansion, service delivery, supervision, and monitoring of vaccine delivery. Under scenario 1 and a baseline price assumption (i.e., donor-funded; government pays 0% of vaccine procurement costs) the respective financial cost per vaccine dose and fully vaccinated child is estimated to be $2.44 and $13.69 in Malawi, $2.28 and $12.49 in Ghana, and $1.78 and $12.66 in Kenya. Estimates of economic costs per dose are between three and five times higher than financial costs. This study adds to the available evidence on vaccine delivery costs. A strength of this paper is that the cost estimates are based on country-specific inputs and assumptions, reflecting variations in program implementation across countries; however, this leads results to be less generalizable and limits comparability cross-country. Additional limitations include assuming an earlier pilot completion date than new projections, as well as a focus on the pilot areas only, necessitating further analysis post pilot completion. This study can inform future costing studies, as well as country decision-making regarding the further use of RTS,S/ASO1$_E$ and the economic implications of continuing vaccination after the pilot ends.

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2. An experience of mass administration of fractional dose inactivated polio vaccine through intradermal needle-free injectors in Karachi, Sindh, Pakistan.

Bullo U, Mehraj J, Raza S, Rasool S, Ansari N, Shaikh A, et al.

BMC Public Health. 2021 Jan 11;21(1):44.
PubMed ID: 33407294

ABSTRACT

BACKGROUND: Inactivated Polio Vaccine (IPV) campaign was conducted in February 2019 in Karachi where needle-free injectors were introduced for the administration of the fractional dose of IPV (fIPV) on a large scale. This study aimed to determine the impact of needle-free injectors on vaccination coverage.

METHODS: In four towns of Karachi, fIPV was given using needle-free injectors “PharmaJet Tropis ID”. Whereas, in six towns full dose of IPV was administered to children of 4-59 months of age. Cluster surveys through rapid convenience assessment method were conducted after the completion of vaccination activity.

RESULTS: A total of 33,815 households’ data was analyzed. Among these, 27,650 (82.8%) children were vaccinated. In fIPV areas, 85.3% of children were vaccinated compared to 79.5% in full dose IPV areas. A comparison of reasons for unvaccinated showed that 1.6% of parents do not give importance to vaccination in fIPV areas compared to 4.2% in full IPV areas (p-value < 0.0001). More children were not vaccinated due to fear of injection 1.8% in full IPV areas compared to 0.7% in fIPV areas (p-value < 0.0001). The source of campaign information shows that more frequent mobile miking 3.1% was observed in fIPV areas compared to 0.4% in full IPV areas (p-value < 0.0001).

CONCLUSIONS: Our analysis supports the fractional dose of IPV in mass campaigns to achieve good vaccination coverage especially using needle-free injectors “PharmaJet Tropis ID” and vigorous social mobilization activities are expedient in accomplishing high coverage.

WEB: 10.1186/s12889-020-10041-8
IMPACT FACTOR: 2.521
CITED HALF-LIFE: 6.0

START COMMENTARY

In this cross-sectional evaluation of an inactivated polio vaccine (IPV) mass administration campaign in Karachi, Pakistan, Bullo *et al.* analyze the impact of a needle-free device "PharmaJet Tropis ID" on IPV coverage, as well as social mobilization activities on community awareness of the immunization campaign. Between February 18th – 26th, 2019, government-led teams administered IPV among children aged 4–59 months, with four towns receiving a fractional dose of IPV (fIPV) using needle-free devices and six towns receiving a full dose of IPV. This study used secondary data from Rapid Convenience Assessment house-to-house cluster surveys conducted by independent monitors. Statistical significance of associations between households in fIPV (n=13,274) and IPV (n=20,541) areas with reasons for missed children and source of campaign information was determined using Pearson's Chi-square tests. Vaccine coverage was 79.5% (n=16,323) and 85.3% (n=11,327) in IPV and fIPV areas, respectively, with more children not vaccinated due to fear of injection 1.8% in IPV areas compared to 0.7% in fIPV areas (p-value < 0.0001). Households identified receiving a higher frequency of mobile miking (3.1% vs. 0.4%, p-value < 0.0001), mosque announcements (9.4% vs. 2.6%, p-value < 0.0001), and visits from social mobilizers (31.1% vs. 22.8%, < 0.0001) in fIPV compared to IPV areas. In contrast, households in fIPV areas identified fewer Community Health Workers visits (36.4% vs. 54.6%, p-value < 0.0001). Limitations include potential response bias from surveyed households, as well as differential baseline vaccination and in fIPV versus IPV towns. This is the first study to compare fIPV and IPV vaccination coverage and community response at the household level using campaign monitoring data in a polio-endemic region. The study found high community acceptance of fIPV, supporting the use of intradermal needle-free injectors in mass vaccination campaigns.

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3. Vaccination strategies for measles control and elimination: time to strengthen local initiatives.

Cutts F, Ferrari M, Krause L, Tatem A, Mosser J.

BMC Med. 2021 Jan 13;19(1):2.

PubMed ID: 33397366

ABSTRACT

BACKGROUND: Through a combination of strong routine immunization (RI), strategic supplemental immunization activities (SIA) and robust surveillance, numerous countries have been able to approach or achieve measles elimination. The fragility of these achievements has been shown, however, by the resurgence of measles since 2016. We describe trends in routine measles vaccine coverage at national and district level, SIA performance and demographic changes in the three regions with the highest measles burden.

FINDINGS: WHO-UNICEF estimates of immunization coverage show that global coverage of the first dose of measles vaccine has stabilized at 85% from 2015 to 19. In 2000, 17 countries in the WHO African and Eastern Mediterranean regions had measles vaccine coverage below 50%, and although all increased coverage by 2019, at a median of 60%, it remained far below levels needed for elimination. Geospatial estimates show many low coverage districts across Africa and much of the Eastern Mediterranean and southeast Asian regions. A large proportion of children unvaccinated for MCV live in conflict-affected areas with remote rural areas and some urban areas also at risk. Countries with low RI coverage use SIAs frequently, yet the ideal timing and target age range for SIAs vary within countries, and the impact of SIAs has often been mitigated by delays or disruptions. SIAs have not been sufficient to achieve or sustain measles elimination in the countries with weakest routine systems. Demographic changes also affect measles transmission, and their variation between and within countries should be incorporated into strategic planning.

CONCLUSIONS: Rebuilding services after the COVID-19 pandemic provides a need and an opportunity to increase community engagement in planning and monitoring services. A broader suite of interventions is needed beyond SIAs. Improved methods for tracking coverage at the individual and community level are needed together with enhanced surveillance. Decision-making needs to be decentralized to develop locally-driven, sustainable strategies for measles control and elimination.

WEB: 10.1186/s12916-020-01843-z
IMPACT FACTOR: 6.782
CITED HALF-LIFE: 5.2

START COMMENTARY

Cutts *et al.* describe trends in three main drivers of measles burden—1) routine immunization (RI) coverage, 2) supplemental immunization activities (SIA) performance, and 3) demographic changes—and propose a change in priorities for measles control strategies post- COVID-19. With a focus on countries within three of the World Health Organization regions with the highest estimated measles mortality, African (AFR), Eastern Mediterranean (EMR), and southeast Asian (SEAR), the authors present plots showing the estimated breakdown of MCV unvaccinated children under age one in relation to conflict- affected, urban and remote rural areas. While direct comparison between countries is limited by potential differences in the completeness of data, most unvaccinated children in EMR live in conflict- affected areas, as do those in some of the largest African countries (e.g., DRC, Ethiopia and Nigeria). A high proportion of unvaccinated children live in remote rural locations in Chad, DRC, Ethiopia, Mauritania and the Republic of Congo. Countries with coverage >80% identified none of these factors in over half the unvaccinated children. These findings suggest that current RI programs often produce unequal levels of RI throughout a country and fail to reach children in high-risk populations. While SIAs can attain higher and more equitable coverage than RI, the authors highlight that SIA coverage in countries with weaker health systems have rarely approached the levels needed for elimination. This article argues for increased political will to fund locally driven strategies (e.g., decentralized, enhanced coverage tracking and surveillance), especially improvements in RI, to make future measles elimination feasible.

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4. Comparing COVID-19 vaccine allocation strategies in India: A mathematical modelling study.

Foy B, Wahl B, Mehta K, Shet A, Menon G, Britto C.

Int J Infect Dis. 2021 Jan 27;103:431-438.
PubMed ID: 33388436

ABSTRACT

BACKGROUND: The development and widespread use of an effective SARS-CoV-2 vaccine could prevent substantial morbidity and mortality associated with COVID-19 and mitigate the secondary effects associated with non-pharmaceutical interventions.

METHODS: We used an age-structured, expanded SEIR model with social contact matrices to assess age-specific vaccine allocation strategies in India. We used state-specific age structures and disease transmission coefficients estimated from confirmed incident cases of COVID-19 between 1 July and 31 August 2020. Simulations were used to investigate the relative reduction in mortality and morbidity of vaccine allocation strategies based on prioritizing different age groups, and the interactions of these strategies with concurrent non-pharmaceutical interventions. Given the uncertainty associated with COVID-19 vaccine development, we varied vaccine characteristics in the modelling simulations.

RESULTS: Prioritizing COVID-19 vaccine allocation for older populations (i.e., >60 years) led to the greatest relative reduction in deaths, regardless of vaccine efficacy, control measures, rollout speed, or immunity dynamics. Preferential vaccination of this group often produced relatively higher total symptomatic infections and more pronounced estimates of peak incidence than other assessed strategies. Vaccine efficacy, immunity type, target coverage, and rollout speed significantly influenced overall strategy effectiveness, with the time taken to reach target coverage significantly affecting the relative mortality benefit comparative to no vaccination.

CONCLUSIONS: Our findings support global recommendations to prioritize COVID-19 vaccine allocation for older age groups. Relative differences between allocation strategies were reduced as the speed of vaccine rollout was increased. Optimal vaccine allocation strategies will depend on vaccine characteristics, strength of concurrent non-pharmaceutical interventions, and region-specific goals.

WEB: 10.1016/j.ijid.2020.12.075
IMPACT FACTOR: 3.202
CITED HALF-LIFE: 5.3

START COMMENTARY

In this mathematical modelling study, Foy *et al.* use an age-structured compartment model, with social contact matrices, to estimate the relative benefit between four COVID-19 vaccination strategies in India: (1) evenly distributing across the entire population versus first distributing to those (2) 20–40 years, (3) 40–60 years, or (4) ≥ 60 years old. Results are presented over a five-year period, varying vaccine characteristics (e.g., sterilizing vs. non-sterilizing immunity, 2-15% of the population vaccinated each month) and control measures resulting in R_0 ranging from 1.8-5.0. In all scenarios considered, prioritizing individuals ≥ 60 years old for vaccination led to the greatest relative reduction in overall mortality. While prioritizing younger populations had a greater impact on reducing incidence of infections relative to prioritizing the older age group, this led to the lowest relative reduction on COVID-19 mortality compared to all other strategies. When vaccines provided sterilizing immunity, the relative reduction in cases and deaths was substantially greater with strong control measures in place; however, relative reductions did not meaningfully change given control measures with a vaccine with non-sterilizing immunity. This model includes a number of key assumptions about COVID-19 epidemiology and transmission dynamics due to limited data availability and evolving scientific understanding of COVID-19 (e.g., many parameters likely vary with age and time, but remain constant in the model). Limitations of this study include not incorporating of a health worker compartment, seasonal forcing, or prior immunity within the population. This study illustrates that prioritized vaccination of older populations may be optimal regardless of vaccine efficacy, dispensation speed, force of infection, and target coverage, and independent of whether NPIs are implemented. In the context of a limited supply of COVID-19 vaccines, these findings can be used to guide vaccine allocation strategies in India and other low- and middle-income countries.

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5. Meningococcal disease epidemiology in Brazil (2005-2018) and impact of MenC vaccination.

Aparecido Nunes A, De Jesus Lopes De Abreu A, Cintra O, A C T Cintra M, Barbosa Coelho E, Nogueira Castro De Barros E.

Vaccine. 2021 Jan 04;39(3):605-616.
PubMed ID: 33358262

ABSTRACT

BACKGROUND: Meningococcal disease (MD) presents a substantial public health problem in Brazil. Meningococcal C conjugate (MenC) vaccination was introduced into the routine infant immunization program in 2010, followed by adolescent vaccination in 2017. We evaluated changes in national and regional MD incidence and mortality between 2005 and 2018, serogroup distribution and vaccine coverage.

METHODS: Data were obtained from national surveillance systems from 2005 to 2018. Age-stratified incidence and mortality rates were calculated and a descriptive time-series analysis was performed comparing rates in the pre-(2005-2009) and post-vaccination (2011-2018) periods; MD due to specific meningococcal serogroups were analyzed in the pre-(2007-2009) and post-vaccination (2011-2018) periods.

RESULTS: From 2005 to 2018, 31,108 MD cases were reported with 6496 deaths; 35% of cases and deaths occurred in children < 5 years. Incidence and mortality rates declined steadily since 2012 in all age-strata, with significantly lower incidence and mortality in the post-vaccine introduction period in children aged < 1-year, 1-4 years, 5-9 years and 10-14 years. A significant decline in MenC disease in children < 5 years was observed following MenC vaccine introduction; infants < 1 year, from 3.30/100,000 (2007-2009) to 1.08/100,000 (2011-2018) and from 1.44/100,000 to 0.42/100,000 in 1-4-year-olds for these periods. Reductions in MenB disease was also observed. MenW remains an important cause of MD with 748 cases reported across 2005-2018. While initial infant vaccination coverage was high (>95% nationwide), this has since declined (to 83% in 2018); adolescent uptake was < 20% in 2017/18). Regional variations in outcomes and vaccine coverage were observed.

CONCLUSION: A substantial decline in incidence and mortality rates due to MD was seen following MenC vaccine introduction in Brazil, especially among children < 5 years chiefly driven by reductions in MenC serogroup. While these benefits are considerable, the prevalence of MD due to other

serogroups such as MenW and MenB remains a concern. A video summary linked to this article can be found on Figshare: https://doi.org/10.6084/m9.figshare.13379612.v1.

WEB: 10.1016/j.vaccine.2020.11.067
IMPACT FACTOR: 3.143
CITED HALF-LIFE: 7.3

START COMMENTARY

In this observational ecological study using national passive surveillance and mortality databases, Aparecido Nunes *et al.* examine trends meningococcal disease and associated serogroups before and after the introduction of the meningococcal C conjugate vaccine (MenC vaccine) into Brazil's National Immunization Program (NIP). From 2005-2018, 31,108 cases and 6,496 deaths were reported, of which 48.0% (n=11,852) were serogrouped between 2007-2018. The majority of serogrouped cases belonged to serogroup C (71.1%), followed by B (19.9%) and W (6.3%). A time-series analysis showed significantly lower mean incidence rates and mortality rates in the period following vaccine introduction (2011-2018) compared to the pre-vaccination period (2007-2009), mainly in children <5 years old. Following introduction, there was a decline in serogroup C incidence, primarily in children 1-4 years old, and more disease in infants was due to serogroup B incidence from 2012 onwards. However, due to incomplete serogroup reporting, results may not be representative of the true epidemiology. MenC vaccine coverage was >95% in infants the first years after its implementation, but has decreased since 2016, with 76.8% coverage nationwide in 2018. Uptake of adolescent vaccination is particularly low; since added to the NIP, only 19.5% of 12–13-year-olds were vaccinated in 2017 and 14.3% of 11–14-year-olds in 2018. A limitation of this study is that all analyses report unadjusted results (i.e., did not account for impact of temporal/historical trend and effect of seasonality). Additionally, because this is an ecological study, it is not possible to determine any association between cases and vaccination status, limiting the ability to infer any direct association of vaccine impact. Despite these limitations, the study provides a useful reference point, with detailed information by age group and region. Vaccination initiatives to improve MenC coverage, as well as against other serotypes, are desirable to reduce disease burden and protect those most vulnerable in Brazil.

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6. Conflict, community, and collaboration: shared implementation barriers and strategies in two polio endemic countries.

Owoaje E, Rahimi A, Kalbarczyk A, Akinyemi O, Peters M, Alonge O.

BMC Public Health. 2020 Dec 22;20(Suppl 4):1178.
PubMed ID: 33339525

ABSTRACT

BACKGROUND: Afghanistan and Nigeria are two of the three remaining polio endemic countries. While these two countries have unique sociocultural characteristics, they share major polio risk factors. This paper describes the countries' shared contexts and highlights important lessons on implementing polio eradication activities among hard-to-reach populations relevant for future global health programs.

METHODS: A grey literature review of the Global Polio Eradication Initiative (GPEI) followed by an online survey was conducted in both countries. The survey was targeted to individuals who have been involved continuously in polio eradication activities for 12 months or more since 1988. A sub-set of respondents from the survey was recruited for key-informant interviews (KII). The survey and KIIs were conducted between September 2018-April 2019. A cross-case comparison analysis was conducted to describe shared implementation challenges, strategies, and unintended consequences of polio eradication activities across these contexts.

RESULTS: Five hundred thirteen and nine hundred twenty-one surveys were completed in Afghanistan and Nigeria respectively; 28 KIIs were conducted in Afghanistan and 29 in Nigeria. Major polio eradication activities in both countries include house-to-house campaigns, cross-border stations, outreach to mobile populations, and surveillance. Common barriers to these activities in both countries include civil unrest and conflict; competing political agendas; and vaccine refusal, fatigue, and mistrust, all of which are all bases for describing hard-to-reach populations. Both countries employed strategies to engage community leadership, political and religious groups through advocacy visits, and recruited community members to participate in program activities to address misconceptions and distrust. Recruitment of female workers has been necessary for accessing women and children in conservative communities. Synergy with other health programs has been valuable; health workers have improved knowledge of the communities they serve which is applicable to other initiatives.

CONCLUSIONS: The power of community engagement at all levels (from leadership to membership) cannot be overstated, particularly in countries facing civil unrest and insecurity. Workforce motivation, community fatigue and mistrust, political priorities, and conflict are intricately interrelated. Community needs should be holistically assessed and addressed; programs must invest in the needs of health workers who engage in these long-term health programs, particularly in unsafe areas, to alleviate demotivation and fatigue.

WEB: 10.1186/s12889-020-09235-x
IMPACT FACTOR: 2.521
CITED HALF-LIFE: 6.0

START COMMENTARY

In this mixed-methods, cross-case comparison analysis, Owoaje *et al.* present findings of implementation challenges, strategies, and unintended consequences of polio eradication activities in Nigeria and Afghanistan between 1988-2019. Standardized surveys were administered to polio-related actors (e.g., government, Global Polio Eradication Initiative partners, non-governmental organizations, research and academic organizations) with at least one year of continuous involvement in polio eradication work, ranging from frontline to subnational to national involvement. Among 513 and 921 surveys conducted between September 2018-January 2019 in Afghanistan and Nigeria, respectively, the most frequently reported implementation barriers were factors related to the external setting, including political, economic, social, technological or environmental settings (69.0% in Afghanistan, 38.3% in Nigeria), followed by the process of implementation, individual barriers, organizational barriers, and lastly, program characteristics. Key informant interviews (n=28 in Afghanistan, n=29 in Nigeria) were conducted between January-April, 2019 using named change agents identified in the surveys. An inductive content analysis approach was used to identify common themes across the different socioecological model levels, highlighting three main challenges: 1) insecurity and armed conflicts, 2) competing political priorities and, 3) mistrust, hesitancy, and fatigue at both the community and health worker level. While these challenges are intricately linked across both countries, the scale and mechanisms through which they emerge, and strategies to combat them are different. For example, successful strategies to address insecurity and armed conflict have been more consultative in Afghanistan (e.g., negotiating “Days of Tranquility”), while in Nigeria the use of military force and externally driven interventions have yielded some positive results (e.g., “Hit and Run” approach). This paper highlights the importance of understanding the underlying mechanisms of implementation barriers to appropriately target strategies for hard-to-reach populations.

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7. Cost-effectiveness of maternal pertussis immunization: Implications of a dynamic transmission model for low- and middle-income countries.

Kim S, Min K, Jung S, Russell L, Toscano C, Minamisava R, et al.

Vaccine. 2021 Jan 26;39(1):147-157.
PubMed ID: 33303182

ABSTRACT

OBJECTIVE: This study evaluates the cost-effectiveness of maternal acellular pertussis (aP) immunization in low- and middle-income countries using a dynamic transmission model.

METHODS: We developed a dynamic transmission model to simulate the impact of infant vaccination with whole-cell pertussis (wP) vaccine with and without maternal aP immunization. The model was calibrated to Brazilian surveillance data and then used to project health outcomes and costs under alternative strategies in Brazil, and, after adjusting model parameter values to reflect their conditions, in Nigeria and Bangladesh. The primary measure of cost-effectiveness is incremental cost (2014 USD) per disability-adjusted life-year (DALY).

RESULTS: The dynamic model shows that maternal aP immunization would be cost-effective in Brazil, a middle-income country, under the base-case assumptions, but would be very expensive at infant vaccination coverage in and above the threshold range necessary to eliminate the disease (90-95%). At 2007 infant coverage (DTP1 90%, DTP3 61% at 1 year of age), maternal immunization would cost < $4,000 per DALY averted. At high infant coverage, such as Brazil in 1996 (DTP1 94%, DTP3 74% at 1 year), cost/DALY increases to $1.27 million. When the model's time horizon was extended from 2030 to 2100, cost/DALY increased under both infant coverage levels, but more steeply with high coverage. The results were moderately sensitive to discount rate, maternal vaccine price, and maternal aP coverage and were robust using the 100 best-fitting parameter sets. Scenarios representing low-income countries showed that maternal aP immunization could be cost-saving in countries with low infant coverage, such as Nigeria, but very expensive in countries, such as Bangladesh, with high infant coverage.

CONCLUSION: A dynamic model, which captures the herd immunity benefits of pertussis vaccination, shows that, in low- and middle-income countries, maternal aP immunization is cost-effective when infant vaccination coverage is moderate, even cost-saving when it is low, but not cost-effective when coverage levels pass 90-95%.

WEB: 10.1016/j.vaccine.2020.09.012
IMPACT FACTOR: 3.143
CITED HALF-LIFE: 7.3

START COMMENTARY

To evaluate the cost-effectiveness of maternal acellular pertussis (aP) immunization in low- and middle-income countries (LMICs) from 2017 to 2030, Kim *et al.* use an age-stratified dynamic transmission model to project health and cost outcomes of two strategies: 1) infant whole-cell pertussis (wP) vaccination administered at age 2, 4, and 6 months, and 2) infant wP vaccination plus maternal aP immunization using Tdap. Originally calibrated to Brazilian surveillance data and then adjusted to reflect parameters in Nigeria and Bangladesh, the best fitting model assumed waning immunity and repeat infections with a lower reporting rate and less severity. The model estimates the number of pertussis cases, hospitalizations, and deaths; incremental cost per disability-adjusted life years (DALYs) averted are presented from the healthcare system perspective. Both health and cost outcomes were discounted at 3%, and costs were expressed in 2014 US dollars. In the base scenario of Brazil comparing moderate (DTP1 90%, DTP3 61%) and high (DTP1 94%, DTP3 74%) infant vaccine coverage, maternal aP immunization would cost $3,194 and $1.27 million per DALY averted, respectively. Results show that maternal aP immunization is cost-effective when infant vaccination coverage is moderate, cost-saving when it is low (e.g., Nigeria), but not cost-effective with high coverage levels above 90–95% (e.g., Bangladesh). Limitations of this study include uncertainty in parameters and using Polish POLYMOD contact matrix as a proxy adjusted for household size. Further, findings may not be generalizable to countries where infants receive aP vaccine. This study is the first to evaluate the cost-effectiveness of maternal aP immunization in LMICs using a dynamic model and can help policymakers identify efficient strategies for pertussis control.

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8. PIPDeploy: Development and implementation of a gamified table top simulation exercise to strengthen national pandemic vaccine preparedness and readiness.

Ghiga I, Richardson S, Álvarez A, Kato M, Naidoo D, Otsu S, et al.

Vaccine. 2021 Jan 23;39(2):364-371.

PubMed ID: 33293160

ABSTRACT

Successful emergency vaccination campaigns rely on effective deployment and vaccination plans. This applies to localised outbreaks as well as for pandemics. In the wake of the 2009 H1N1 influenza pandemic, analysis of the global Vaccine Deployment Initiative, through which the World Health Organization (WHO) donated pandemic influenza vaccines to countries in need, revealed that an absence of vaccine deployment plans in many countries significantly hindered vaccine deployment. Through the Pandemic Influenza Preparedness Framework adopted by the World Health Assembly in 2011, WHO is engaging in several capacity building activities to improve pandemic influenza preparedness and response and make provisions for access to vaccines and sharing of other benefits. The Framework calls for the development and exercise of operational plans for deployment of influenza vaccines to enhance pandemic preparedness. To this end, WHO has supported the development of PIPDeploy, an interactive, in-person table top simulation exercise to facilitate learning for emergency preparedness. It employs various game design elements including a game board, time pressure, leaderboards and teams to enhance participants' motivation. PIPDeploy formed part of five WHO Pandemic Influenza Vaccine Deployment Workshops attended by national-level managers responsible for pandemic influenza vaccine response predominantly in non-producing countries. The purpose of this study was to describe the features and application of PIPDeploy, and present findings of the evaluation of participants' experiences during the simulation involving a "hot wash" discussion and collection of quantitative data. The simulation's instructional approach was widely accepted by participants, who reported that the format was novel and engaging. They reflected on its utility for identifying gaps in their own vaccine deployment plans and regulatory frameworks for importation of vaccine products. All participants found the simulation relevant to their professional objectives. A range of other potential applications were suggested, including PIPDeploy's adaptation to sub-national contexts and to other epidemic diseases.

WEB: 10.1016/j.vaccine.2020.11.047
IMPACT FACTOR: 3.143
CITED HALF-LIFE: 7.3

START COMMENTARY

Ghiga *et al.* describe and present findings from qualitative and quantitative participant evaluations of PIPDeploy, an in-person gamified simulation exercise aimed at strengthening national pandemic vaccine preparedness and readiness. In PIPDeploy, participants move sequentially through five board-game-like missions (each 55-85 minutes long) as leaders from a fictitious non-vaccine-producing country, and collect cards representing resources for pandemic response. At the end of each mission, participants get "mission rewards" (i.e., key take-home messages and infographics), followed by a discussion led by the facilitator to synthesize of key concepts and knowledge of planning for deployment of vaccines for pandemic response. Between February and December, 2019, PIPDeploy exercises took place at WHO Pandemic Influenza Vaccine Deployment Workshops in Washington, D.C., United States, Dushanbe, Tajikistan, Manila, Philippines, Lagos, Nigeria, Hanoi, Viet Nam. The qualitative session evaluations found that participants had a clear understanding of the rules and purpose of the PIPDeploy simulation, considering it an engaging tool for imparting knowledge on deployment and vaccination planning. All respondents (n=79) agreed that they "learned one or more things [that would] allow [them] to increase preparedness and readiness for deployment of pandemic influenza vaccine in [their] country." Suggestions included adapting PIPDeploy to other epidemic threats and for more nuanced scenarios (e.g., multiple-dose pandemic vaccines, subnational pandemic response). PIPDeploy provides capacity building for influenza preparedness and may serve as a foundation for vaccine response in the face of other pandemic threats.

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9. Pregnant women & vaccines against emerging epidemic threats: Ethics guidance for preparedness, research, and response.

Krubiner C, Faden R, Karron R, Little M, Lyerly A, Abramson J, et al.

Vaccine. 2021 Jan 26;39(1):85-120.
PubMed ID: 31060949

ABSTRACT

Zika virus, influenza, and Ebola have called attention to the ways in which infectious disease outbreaks can severely - and at times uniquely - affect the health interests of pregnant women and their offspring. These examples also highlight the critical need to proactively consider pregnant women and their offspring in vaccine research and response efforts to combat emerging and re-emerging infectious diseases. Historically, pregnant women and their offspring have been largely excluded from research agendas and investment strategies for vaccines against epidemic threats, which in turn can lead to exclusion from future vaccine campaigns amidst outbreaks. This state of affairs is profoundly unjust to pregnant women and their offspring, and deeply problematic from the standpoint of public health. To ensure that the needs of pregnant women and their offspring are fairly addressed, new approaches to public health preparedness, vaccine research and development, and vaccine delivery are required. This Guidance offers 22 concrete recommendations that provide a roadmap for the ethically responsible, socially just, and respectful inclusion of the interests of pregnant women in the development and deployment of vaccines against emerging pathogens. The Guidance was developed by the Pregnancy Research Ethics for Vaccines, Epidemics, and New Technologies (PREVENT) Working Group - a multidisciplinary, international team of 17 experts specializing in bioethics, maternal immunization, maternal-fetal medicine, obstetrics, pediatrics, philosophy, public health, and vaccine research and policy - in consultation with a variety of external experts and stakeholders.

WEB: 10.1016/j.vaccine.2019.01.011
IMPACT FACTOR: 3.143
CITED HALF-LIFE: 7.3

START COMMENTARY

Krubiner *et al.* present guidance offering 22 concrete recommendations to ensure pregnant women benefit fairly from advances in biomedicine, especially in the development and deployment of

vaccines against emerging pathogens. Developed by 17 international experts in the Pregnancy Research Ethics for Vaccines, Epidemics, and New Technologies (PREVENT) Working Group, the recommendations are organized around three key areas: 1) public health emergency preparedness (n=6), 2) research and development of vaccines against emerging pathogenic threats (n=10), and 3) vaccine delivery (n=6). Each recommendation specifies the actors to whom it is directed (e.g., global and national policymakers, regional and national regulatory authorities, funders and sponsors, vaccine manufacturers, research institutions, trial networks and research groups, individual researchers, oversight bodies, ethics review committees, community advisory boards, and civil society organizations). Specifically, Table A highlights considerations for assessing risks and benefits of including pregnant women in vaccine research and delivery. This article describes how current practices of treating pregnant women in vaccine research and deployment is not acceptable and gives guidance to ensure pregnant women and their offspring are not unjustifiably excluded from participating in vaccine studies, and can instead benefit from advances in vaccine technologies and vaccines against emerging and reemerging pathogenic threats.

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10. Mapping routine measles vaccination in low- and middle-income countries.

Local Burden of Disease Vaccine Coverage Collaborators., Sbarra, A.N., Rolfe, S. et al.
Nature. 2020 Dec 16;589:85-120.
PubMed ID: 33328634

ABSTRACT

The safe, highly effective measles vaccine has been recommended globally since 1974, yet in 2017 there were more than 17 million cases of measles and 83,400 deaths in children under 5 years old, and more than 99% of both occurred in low- and middle-income countries (LMICs). Globally comparable, annual, local estimates of routine first-dose measles-containing vaccine (MCV1) coverage are critical for understanding geographically precise immunity patterns, progress towards the targets of the Global Vaccine Action Plan (GVAP), and high-risk areas amid disruptions to vaccination programmes caused by coronavirus disease 2019 (COVID-19). Here we generated annual estimates of routine childhood MCV1 coverage at 5 × 5-km^2 pixel and second administrative levels from 2000 to 2019 in 101 LMICs, quantified geographical inequality and assessed vaccination status by geographical remoteness. After widespread MCV1 gains from 2000 to 2010, coverage regressed in more than half of the districts between 2010 and 2019, leaving many LMICs far from the GVAP goal of 80% coverage in all districts by 2019. MCV1 coverage was lower in rural than in urban locations, although a larger proportion of unvaccinated children overall lived in urban locations; strategies to provide essential vaccination services should address both geographical contexts. These results provide a tool for decision-makers to strengthen routine MCV1 immunization programmes and provide equitable disease protection for all children.

WEB: https://doi.org/10.1038/s41586-020-03043-4
IMPACT FACTOR: 42.779
CITED HALF-LIFE: 10.9

START COMMENTARY

Sbarra et al., report the first comprehensive analysis of all available vaccine coverage data to produce subnational estimates of annual, routine one-dose MCV1 coverage in all low- and middle-income countries (LMICs). Using data from the Global Health Data Exchange and 354 population-based household surveys from 101 LMICs, the authors fit a geostatistical model with correlated errors across space and time to predict MCV1 coverage estimates and uncertainty (5 × 5-km2 level

and aggregated district second-level) from 2000 to 2019. Estimates used environmental, sociodemographic and health-related geospatial and national-level covariates, and were calibrated to results from the Global Burden of Disease 2019. Among approximately 1.70 million children, MCV1 coverage was 65.6% (95% UI: 64.2–67.1%) in 2000 and 81.0% (95% UI: 79.2–82.7%) in 2019, with coverage increasing in 69.9% (95% UI: 64.4–75.2%) of countries and 57.4% (95% UI: 50.4–64.6%) of districts (n=20,795 districts). The three lowest-coverage districts in 2019 were all located in Afghanistan: Poruns (9.2%, 95% UI: 2.0–25.5%), Wama (12.1%, 95% UI: 2.8–32.6%) and Waygal (12.7%, 95% UI: 3.0–34.2%). Results show variability in urban and rural contributions to unvaccinated populations, with lower MCV1 coverage in rural locations, despite a larger proportion of the population in urban locations overall, suggesting locally-tailored strategies are needed to address both contexts. From 2000–2010 there was progress towards reducing subnational heterogeneity and increases in district coverage (70.5%, 95% UI: 66.0–75.4%). However, from 2010–2019 progress slowed and coverage increased in only 40.1% (95% UI: 34.2–46.9%) of districts, with a regression of coverage in some cases compared to the 2000–2010 period. While a noteworthy 62 out of 101 LMICs increased MCV1 coverage while decreasing subnational geographical inequalities from 2000–2019, only 15 countries and 33.2% of districts in 2019 had a high probability of reaching the target of 80% district-level MCV1 coverage. This study provides a novel tool for decision-makers to use in developing measles vaccination strategies and advocating for strong, sustainable and equitable immunization programs needed to reach key coverage targets.

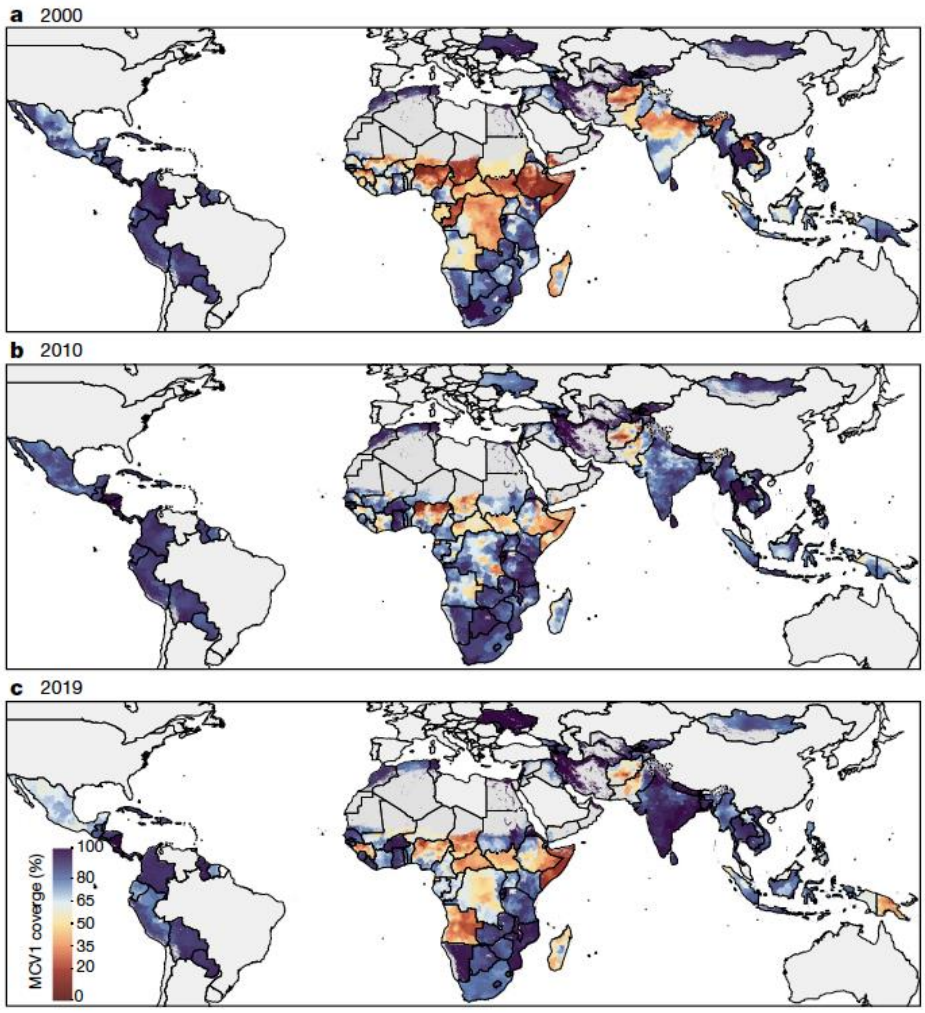

Figure Map of estimated MCV1 coverage among districts in 101 LMICs in 2000 (a), 2010 (b) and 2019 (c). Figure 1 in manuscript. Interactive maps available at: https://vizhub.healthdata.org/lbd/mcv.

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Appendix

The literature search for the February 2021 Vaccine Delivery Research Digest was conducted on January 16, 2021. We searched English language articles indexed by the US National Library of Medicine and published between December 15, 2020 and January 14, 2020. The search resulted in 326 items.

SEARCH TERMS

(((((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]) (“2020/12/15”[PDAT] : “2021/01/14”[PDAT]))