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VACCINE DELIVERY RESEARCH DIGEST

UNIVERSITY OF WASHINGTON STRATEGIC ANALYSIS, RESEARCH & TRAINING (START) CENTER

REPORT TO THE BILL & MELINDA GATES FOUNDATION

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- A study to assess vaccine wastage; provider knowledge, attitudes, and practices related to vaccine wastage; and missed opportunities for vaccination in health facilities in Nigeria.

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DETAILS OF ARTICLES

1. [Predictors of measles vaccination coverage among children 6-59 months of age in the Democratic Republic of the Congo.](#)

Ashbaugh HR, Hoff AN, Doshi RH, Alfonso VH, Gadoth A, Mukadi P, et al.

Vaccine. 2017 Dec 13. pii: S0264-410X(17)31613-4. [Epub ahead of print]

PubMed ID: 29248265

ABSTRACT

BACKGROUND:

Measles is a significant contributor to child mortality in the Democratic Republic of the Congo (DRC), despite routine immunization programs and supplementary immunization activities (SIA). Further, national immunization coverage levels may hide disparities among certain groups of children, making effective measles control even more challenging. This study describes measles vaccination coverage and reporting methods and identifies predictors of vaccination among children participating in the 2013-2014 DRC Demographic and Health Survey (DHS).

METHODS:

We examined vaccination coverage of 6947 children aged 6-59 months. A multivariate logistic regression model was used to identify predictors of vaccination among children reporting vaccination via dated card in order to identify least reached children. We also assessed spatial distribution of vaccination report type by rural versus urban residence.

RESULTS:

Urban children with educated mothers were more likely to be vaccinated (OR = 4.1, 95% CI: 1.6, 10.7) versus children of mothers with no education, as were children in wealthier rural families (OR = 2.9, 95% CI: 1.9, 4.4). At the provincial level, urban areas more frequently reported vaccination via dated card than rural areas.

CONCLUSIONS:

Results indicate that, while the overall coverage level of 70% is too low, socioeconomic and geographic disparities also exist which could make some children even less likely to be vaccinated. Dated records of measles vaccination must be increased, and groups of children with the greatest need should be targeted. As access to routine vaccination services is limited in DRC, identifying and targeting under-reached children should be a strategic means of increasing country-wide effective measles control.

WEB: [10.1016/j.vaccine.2017.11.049](http://dx.doi.org/10.1016/j.vaccine.2017.11.049)

IMPACT FACTOR: 3.41

CITED HALF-LIFE: 5.90

START EDITORIAL COMMENT: Measles vaccination in this study was reported in three ways: “dated cards” if mothers possessed a vaccination card provided by a health care worker (HCW) indicating the date the child was vaccinated for measles; “marked card” if mothers possessed a vaccination card that was marked to indicate measles vaccine was administered, but lacked a date; and “maternal recall” report, if mothers either did not have a card or could not provide a card at the time of interview, yet reported the child had been vaccinated for measles. Additionally, maps by province were created to analyze spatial distribution of vaccination report type. Results showed there were 30%, 2,058 children, who were unvaccinated and 70%, 4,889 children, vaccinated for measles. Of those who reporting vaccination, 773 (16%) reported using a dated card, 126 (3%) using a marked card, and 3,990 (82%) using maternal recall. Children of urban, educated mothers and children of mothers from wealthy rural families were significantly more likely to be vaccinated. Although the study was limited by the lack of



individual-level data for measles immunization campaigns, it highlights the impact of socioeconomic status, education, and rurality in driving vaccination rates and suggests that mothers that are poor, uneducated or live in rural areas in the DRC should be targeted specifically to improve measles immunization coverage.

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2. [Cost-effectiveness of rotavirus vaccination in Ghana: Examining impacts from 2012 to 2031.](#)

Nonvignon, J, Atherly D, Pecenka C, Aikins M, Gazley L, Groman D, et al.

Vaccine. 2017 Dec 6. pii: S0264-410X(17)31723-1. [Epub ahead of print]

PubMed ID: 29223486

ABSTRACT

BACKGROUND:

Diarrhea causes about 10% of all deaths in children under five years globally, with rotavirus causing about 40% of all diarrhea deaths. Ghana introduced rotavirus vaccination as part of routine immunization in 2012 and it has been shown to be effective in reducing disease burden in children under five years. Ghana's transition from low to lower-middle income status in 2010 implies fewer resources from Gavi as well as other major global financing mechanisms. Ghana will soon bear the full cost of vaccines. The aim of this study was to estimate the health impact, costs and cost-effectiveness of rotavirus vaccination in Ghana from introduction and beyond the Gavi transition.

METHODS:

The TRIVAC model is used to estimate costs and effects of rotavirus vaccination from 2012 through 2031. Model inputs include demographics, disease burden, health system structure, health care utilization and costs as well as vaccine cost, coverage, and efficacy. Model inputs came from local data, the international literature and expert consultation. Costs were examined from the health system and societal perspectives.

RESULTS:

The results show that continued rotavirus vaccination could avert more than 2.2 million cases and 8900 deaths while saving US\$6 to US\$9 million in costs over a 20-year period. The net cost of vaccination program is approximately US\$60 million over the same period. The societal cost per DALY averted is US\$238 to US\$332 with cost per case averted ranging from US\$27 to US\$38. The cost per death averted is approximately US\$7000.

CONCLUSION:

The analysis shows that continued rotavirus vaccination will be highly cost-effective, even for the period during which Ghana will assume responsibility for purchasing vaccines after transition from Gavi support.

WEB: [10.1016/j.vaccine.2017.11.080](https://doi.org/10.1016/j.vaccine.2017.11.080)

IMPACT FACTOR: 3.41

CITED HALF-LIFE: 5.90

START EDITORIAL COMMENT: In Ghana, diarrhea causes 28% of hospital admissions for children under five years. The rationale for this timeline was to cover the period when Ghana is no longer considered eligible for GAVI subsidies. With cost-effectiveness ratios of between \$238 and \$332 per DALY averted, rotavirus vaccination was judged to be highly cost-effective by conventional standards even after Ghana takes on the responsibility for rotavirus vaccine purchase without GAVI support. Although the study had a number of limitations—uncertainty around modeling estimates, differences in tariffs assessed in the study and the costs of care, and basing treatment seeking behavior on local expert opinion which may not reflect behaviors across the country—it is clear that Ghana will continue to reap benefits from rotavirus vaccination well into the future.

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3. [Rubella vaccination in India: identifying broad consequences of vaccine introduction and key knowledge gaps.](#)

Winter AK, Pramanik S, LEessler J, Ferrari M, Grenfell BT, Metcalf CJE.

Epidemiol Infect. 2018 Jan;146(1):65-77. [Epub ahead of print]

PubMed ID: 29198212

ABSTRACT

Rubella virus infection typically presents as a mild illness in children; however, infection during pregnancy may cause the birth of an infant with congenital rubella syndrome (CRS). As of February 2017, India began introducing rubella-containing vaccine (RCV) into the public-sector childhood vaccination programme. Low-level RCV coverage among children over several years can result in an increase in CRS incidence by increasing the average age of infection without sufficiently reducing rubella incidence. We evaluated the impact of RCV introduction on CRS incidence across India's heterogeneous demographic and epidemiological contexts. We used a deterministic age-structured model that reflects Indian states' rural and urban area-specific demography and vaccination coverage levels to simulate rubella dynamics and estimate CRS incidence with and without RCV introduction to the public sector. Our analysis suggests that current low-level private-sector vaccination has already slightly increased the burden of CRS in India. We additionally found that the effect of public-sector RCV introduction depends on the basic reproductive number, R_0 , of rubella. If R_0 is five, a value empirically estimated from an array of settings, CRS incidence post-RCV introduction will likely decrease. However, if R_0 is seven or nine, some states may experience short-term or annual increases in CRS, even if a long-term total reduction in cases (30 years) is expected. Investment in population-based serological surveys and India's fever/rash surveillance system will be key to monitoring the success of the vaccination programme.

WEB: [10.1017/S0950268817002527](https://doi.org/10.1017/S0950268817002527)

IMPACT FACTOR: 1.31

CITED HALF-LIFE: 6.60

START EDITORIAL COMMENT: Low level rubella vaccination may increase the incidence of congenital rubella syndrome (CRS) by increasing the average age of infection without substantially reducing rubella incidence. This study assessed the impact of introduction of rubella vaccination on congenital rubella syndrome (CRS) in India. Considering the substantial heterogeneity in the epidemiology of rubella and CRS is the large country of India, the study found that the current low level of rubella vaccination increases CRS in India. With increased rubella vaccination coverage in India, the rate of CRS will likely increase initially and then decrease. The study emphasized the impact of rubella serological surveys and fever/rash surveillance on the success of India's nascent rubella vaccination program.

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4. [Challenges of vaccine presentation and delivery: How can we design vaccines to have optimal programmatic impact?](#)

Giersing BK, Kahn AL, Jarrahan C, Mvundura M, Rodriguez C, et al.

Vaccine. 2017 Dec 14;35(49 Pt A):6793-6797.

PubMed ID: 28566254

ABSTRACT

Immunization program delivery strategies that enable high vaccine coverage, particularly in inaccessible and remote areas, are critical to achieving optimal vaccine impact. In addition to demonstration of safety and efficacy, there are many factors that influence whether a newly licensed vaccine will be introduced into a country's national immunization program, particularly in resource-constrained environments. This paper describes three case studies of novel approaches that represent the potential for improved programmatic impact by increasing vaccine accessibility in different ways. However, the pathway to regulatory approval, policy recommendation, and program introduction in low- and middle-income countries is complex, requiring engagement with multiple, diverse stakeholders. Consideration of aspects that affect uptake in low- and middle-income countries, during the product development stage, will help better position new or second-generation vaccine products for successful implementation to achieve public health impact.

WEB: 10.1371/journal.pone.0187446

IMPACT FACTOR: 3.41

CITED HALF-LIFE: 5.90

START EDITORIAL COMMENT: Using three case studies—fractional dose inactivated polio vaccine (intradermal delivery), controlled temperature chain meningitis vaccine, and microarray patches for measles-rubella vaccine delivery—authors examined the challenges of vaccine presentation and delivery with a view to improve overall vaccine impact. The authors recommended that manufacturers of new or second-generation vaccines consider aspects of products that affect or might affect uptake in low- and middle-income countries as they develop products to achieve maximum public health impact.

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5. [A rapid qualitative assessment of oral cholera vaccine anticipated acceptability in a context of resistance towards cholera intervention in Nampula, Mozambique.](#)

Démolis R, Botão C, Heyerdahl LW, Gessner BD, Cavailler P, Sinai C, et al.
Vaccine. 2017 Nov 23. pii: S0264-410X(17)31495-0. [Epub ahead of print]
PubMed ID: 29174106

ABSTRACT

INTRODUCTION:

While planning an immunization campaign in settings where public health interventions are subject to politically motivated resistance, designing context-based social mobilization strategies is critical to ensure community acceptability. In preparation for an Oral Cholera Vaccine campaign implemented in Nampula, Mozambique, in November 2016, we assessed potential barriers and levers for vaccine acceptability.

METHODS:

Questionnaires, in-depth interviews, and focus group discussions, as well as observations, were conducted before the campaign. The participants included central and district level government informants (national immunization program, logistics officers, public health directors, and others), community leaders and representatives, and community members.

RESULTS:

During previous well chlorination interventions, some government representatives and health agents were attacked, because they were believed to be responsible for spreading cholera instead of purifying the wells. Politically motivated resistance to cholera interventions resurfaced when an OCV campaign was considered. Respondents also reported vaccine hesitancy related to experiences of problems during school-based vaccine introduction, rumors related to vaccine safety, and negative experiences following routine childhood immunization. Despite major suspicions associated with the OCV campaign, respondents' perceived vulnerability to cholera and its perceived severity seem to override potential anticipated OCV vaccine hesitancy.

DISCUSSION:

Potential hesitancy towards the OCV campaign is grounded in global insecurity, social disequilibrium, and perceived institutional negligence, which reinforces a representation of estrangement from the central government, triggering suspicions on its intentions in implementing the OCV campaign. Recommendations include a strong involvement of community leaders, which is important for successful social mobilization; representatives of different political parties should be equally involved in social mobilization efforts, before and during campaigns; and public health officials should promote other planned interventions to mitigate the lack of trust associated with perceived institutional negligence. Successful past initiatives include public intake of purified water or newly introduced medication by social mobilizers, teachers or credible leaders.

WEB: [10.1016/j.vaccine.2017.10.087](https://doi.org/10.1016/j.vaccine.2017.10.087)

IMPACT FACTOR: 3.41

CITED HALF-LIFE: 5.90

START EDITORIAL COMMENT: Researchers designed a rapid anthropological assessment to investigate potential oral cholera vaccine (OCV) acceptability in the context of resistance to cholera treatment using semi-structured interviews or focus groups. Researchers found that politically-motivated resistance to a possible OCV campaign was driven by previous perceived mistrust of government and government



programs. Researchers also found a perception of fear of vulnerability to cholera and severity of cholera which would likely override the hesitancy to participate in a potential OCV campaign. This research study highlighted three factors that would act as possible avenues to improve acceptability of OCV and other campaigns and mitigate the negative perception attributed to the involvement of government in healthcare activities: (1) the importance of local political leader involvement in mobilization campaigns, (2) a politically-balanced approach to health campaigns, and (3) social mobilization in anticipation of future interventions and health campaigns.

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6. [The effect of cool water pack preparation on vaccine vial temperatures in refrigerators.](#)

Goldwood G, Diesburg S.

Vaccine. 2018 Jan 2;36(1):128-133.

PubMed ID: 29174313

ABSTRACT

Cool water packs are a useful alternative to ice packs for preventing unintentional freezing of vaccines during outreach in some situations. Current guidelines recommend the use of a separate refrigerator for cooling water packs from ambient temperatures to prevent possible heat degradation of adjacent vaccine vials. To investigate whether this additional equipment is necessary, we measured the temperatures that vaccine vials were exposed to when warm water packs were placed next to vials in a refrigerator. We then calculated the effect of repeated vial exposure to those temperatures on vaccine vial monitor status to estimate the impact to the vaccine. Vials were tested in a variety of configurations, varying the number and locations of vials and water packs in the refrigerator. The calculated average percentage life lost during a month of repeated warming ranged from 20.0% to 30.3% for a category 2 (least stable) vaccine vial monitor and from 3.8% to 6.0% for a category 7 (moderate stability) vaccine vial monitor, compared to 17.0% for category 2 vaccine vial monitors and 3.1% for category 7 vaccine vial monitors at a constant 5 °C. The number of vials, number of water packs, and locations of each impacted vial warming and therefore percentage life lost, but the vaccine vial monitor category had a higher impact on the average percentage life lost than any of the other parameters. The results suggest that damage to vaccines from repeated warming over the course of a month is not certain and that cooling water packs in a refrigerator where vaccines are being stored may be a useful practice if safe procedures are established.

WEB: [10.1016/j.vaccine.2017.11.024](https://doi.org/10.1016/j.vaccine.2017.11.024)

IMPACT FACTOR: 3.41

CITED HALF-LIFE: 5.90

START EDITORIAL COMMENT: Cool water packs may substitute for ice packs to prevent unintentional freezing of vaccines during outreaches. This study assessed the rationale of separate refrigerators to prepare cool water packs to avoid contact of ambient temperature water packs with heat sensitive vaccines if a single refrigerator is used. Researchers estimated the temperatures that vaccine vials were exposed to when they were placed next to water packs in a single refrigerator using an estimate of average percent of vaccine life lost during a month of repeated warming of vaccines. The study found variable and uncertain temperature degradation in vaccines depending on the level of thermostability, number of water packs and vaccines placed in refrigerators, and positioning of water packs relative to vaccines. They concluded that multiple refrigerators to cool vaccines and prepare water packs may be unnecessary given establishment of safe procedures.

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7. [A cluster randomized trial to determine the effectiveness of a novel, digital pendant and voice reminder platform on increasing infant immunization adherence in rural Udaipur, India.](#)

Nagar R, Venkat P, Stone LD, Engel KA, Sadda P, Shahnawaz M.

Vaccine. 2017 Nov 18. pii: S0264-410X(17)31582-7. [Epub ahead of print]

PubMed ID: 29162321

ABSTRACT

BACKGROUND:

Five hundred thousand children under the age of 5 die from vaccine preventable diseases in India every year. More than just improving coverage, increasing timeliness of immunizations is critical to ensuring infant health in the first year of life. Novel, culturally appropriate community engagement strategies are worth exploring to close the immunization gap. In our study, a digital NFC (Near Field Communication) pendant worn on black thread and voice call reminder system was tested for the effectiveness in improving DTP3 adherence within 2 monthly camps from DTP1 administration.

METHOD:

A cluster randomized controlled trial was conducted in which 96 village health camps were randomized to 3 arms: NFC sticker, NFC pendant, and NFC pendant with voice call reminder in local dialect. Randomization was done across 5 blocks in the Udaipur District serviced by Seva Mandir from August 2015 to April 2016.

RESULTS:

In terms of our three primary outcomes related to DTP3 adherence, point estimates show conflicting results. Two outcomes presented adherence in the control. DTP3 completion within two camps after DTP1 showed higher adherence in the Control (Sticker) (74.2%) arm compared to the Pendant (67.2%) and Pendant and Voice arms (69.3%). Likewise, the estimate for DTP3 completion within 180 days of birth in the Control (Sticker) (69.4%) arm was higher than estimates in the Pendant (57.4%) and Pendant and Voice arms (58.7%). However, one outcome displayed higher adherence in the intervention. DTP3 completion within two months from the time of registration was higher in the Pendant (37.7%) and Pendant and Voice arms (38.7%) compared to the Control (Sticker) arm (27.4%). In all primary outcomes, differences in adherence were statistically insignificant both before and after controlling for confounding factors. In terms of secondary outcomes, our results suggest that providing a necklace generated significant community discussion ($H = 8.8796$, $df = 2$, $p = .0118$), had strong satisfaction among users ($\chi^2=26.039$, $df = 4$, $p < .0001$), and resulted in increased visibility within families (grandmothers: $\chi^2=34.023$, $df = 2$, $p < .0001$, fathers: $\chi^2=34.588$, $df = 2$, $p < .0001$).

CONCLUSION:

Neither the NFC necklace nor the necklace with additional voice call reminders in the local dialect directly resulted in an increase in infant immunization timeliness through DTP3, the primary outcome. Still our process outcomes suggest that our culturally symbolic necklace has potential to be an assistive tool in immunization campaigns. Follow-on work will seek to examine whether positive behavior change towards vaccines can be fostered with earlier engagement of this platform beginning in the prenatal stage, under a continuum of care framework.

WEB: [10.1016/j.vaccine.2017.11.023](https://doi.org/10.1016/j.vaccine.2017.11.023)

IMPACT FACTOR: 3.41

CITED HALF-LIFE: 5.90

START EDITORIAL COMMENT: Near-field communication (NFC) is a series of protocols that allows two electronic devices to communicate within 4 cm of each other. This cluster randomized trial assessed the impact of a NFC pendants, with and without voice call reminder, on DPT vaccination adherence in



Udaipur, India. Investigators found mixed results but leaning towards the fact that NFC pendants, with and without voice call reminders, did not improve DPT vaccination adherence. However, the NFC pendants appeared to create a community discussion and were well-accepted in the community. It appears that the NFC technology may have applicability to improve vaccination adherence with earlier engagement by parents with the technology.

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8. [Postneonatal mortality impacts following grants from the Gavi Vaccine Alliance: an econometric analysis from 2000 to 2014.](#)

Kolesar RJ, Audibert M.

Public Health. 2017 Dec;153:163-171.

PubMed ID: 29102832

ABSTRACT

We completed a retrospective multivariate panel study to evaluate the effect of Gavi Vaccine Alliance grants on vaccine-preventable disease (VPD) postneonatal mortality. We separately tested a composite VPD mortality rate and five vaccine-preventable mortality rates: pertussis, meningitis, measles, diarrhea, and pneumonia (lower-respiratory infection) as dependent variables. All 77 countries eligible for Gavi assistance from 2000 to 2014 were included in the study. To isolate the effect of Gavi funding in our primary model, we controlled for known and likely predictors of child mortality. We found evidence that, among other factors, Gavi investment, antenatal care access, and girls' primary education are important elements to reduce vaccine-preventable mortality rates. For every \$1 per capita invested by the Gavi Vaccine Alliance, there are statistically significant effects decreasing the VPD postneonatal mortality rate by 1.848 per 1000 live births. We also found Gavi investments to be significantly associated with reductions in three VPD-specific rates: pertussis, meningitis, and pneumonia. We conclude that Gavi investments in developing country immunization programs have measurably contributed to reductions in postneonatal VPD mortality rates.

WEB: [10.1016/j.puhe.2017.08.014](https://doi.org/10.1016/j.puhe.2017.08.014)

IMPACT FACTOR: 1.53

CITED HALF-LIFE: 1.50

START EDITORIAL COMMENT: In this econometric analysis using data from all 77 GAVI-eligible countries, investigators sought to isolate the impact of GAVI funding on vaccine-preventable disease (VPD) mortality in the post-neonatal period. They found that GAVI funding had a remarkable impact on VPD post-neonatal mortality between 2000 and 2014: for every \$1 dollar per capita invested by GAVI, there was a significant reduction in VPD post-neonatal mortality of 1.8 per 1,000 live births with significant disease-specific mortality rate reductions observed for pertussis, meningitis, and pneumonia. This study is a strong endorsement of the return on investment in vaccine spending by GAVI.

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9. [Vaccination timeliness in preterm infants: An integrative review of the literature.](#)

Sisson H, Gardiner E, Watson R.

J Clin Nurs. 2017 Dec;26(23-24):4094-4104.

PubMed ID: 28618109

ABSTRACT

AIMS AND OBJECTIVES:

To take a systematic approach to reviewing the scientific literature examining the timeliness of vaccination in preterm infants and to identify any factors associated with timeliness.

BACKGROUND:

Preterm infants are vulnerable to infection and guidance advocates they are vaccinated in accordance with their full-term peers. Vaccination is well tolerated and protective immune responses are observed, yet some early enquiries suggest that preterm infants experience unwarranted delays. The recent surge in pertussis cases and the increase in vaccinations administered make this a topic requiring further exploration.

DESIGN:

An integrative review of the empirical literature.

METHODS:

Studies were identified following a search of Medline, Academic Search Premier, Cochrane Database of Systematic Reviews and the Cumulative Index to Nursing and Allied Health Literature. The review methods used were influenced by a narrative synthesis approach. The retrieval of papers adhered to recognised reporting standards.

RESULTS:

Fourteen studies were identified, which indicated that infants with the lowest gestational ages and birthweights experience the greatest delays. Vaccination timeliness is influenced by hospitalisation and increased postdischarge follow-up. There was a lack of consensus to indicate that parental socio-economic status and level of education were indicators for a delay. The studies propose that many delays are unjustified and not according to genuine contraindications.

CONCLUSION:

This review indicates that preterm infants are not vaccinated in a timely manner. Those involved in vaccinating preterm infants must be informed of the genuine contraindications to avoid unnecessary delays putting preterm infants at an increased risk of infection.

RELEVANCE TO CLINICAL PRACTICE:

Care providers should acknowledge the risk of a delay in preterm infants and actively promote vaccination in this population. Regular training should help to negate the occurrence of inappropriate delays, and careful discharge planning is needed to ensure that preterm infants are vaccinated on time.

WEB: 10.1111/jocn.13916

IMPACT FACTOR: 3.41

CITED HALF-LIFE: 5.90

START EDITORIAL COMMENT: Preterm infants often experience delays in vaccination despite their increased vulnerability and their ability to mount the appropriate immune response to benefit from vaccines. This review identified hospitalization and post-discharge follow-up (well visits) as improving timeliness of vaccination among preterm infants. The authors recommend provider training to improve timeliness of vaccination among preterm infants.

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10. [Vaccine wastage in Nigeria: An assessment of wastage rates and related vaccinator knowledge, attitudes and practices.](#)

Wallace AS, Daniels D, Nwaze E, Abanida E, Mahmud M, Willis F, et al.

Vaccine. 2017 Dec 4;35(48 Pt B):6751-6758.

PubMed ID: 29066189

ABSTRACT

INTRODUCTION:

The introduction of new vaccines highlights concerns about high vaccine wastage, knowledge of wastage policies and quality of stock management. However, an emphasis on minimizing wastage rates may cause confusion when recommendations are also being made to reduce missed opportunities to routinely vaccinate children. This concern is most relevant for lyophilized vaccines without preservatives [e.g. measles-containing vaccine (MCV)], which can be used for a limited time once reconstituted.

METHODS:

We sampled 54 health facilities within 11 local government areas (LGAs) in Nigeria and surveyed health sector personnel regarding routine vaccine usage and wastage-related knowledge and practices, conducted facility exit interviews with caregivers of children about missed opportunities for routine vaccination, and abstracted vaccine stock records and vaccination session data over a 6-month period to calculate wastage rates and vaccine vial usage patterns.

RESULTS:

Nearly half of facilities had incomplete vaccine stock data for calculating wastage rates. Among facilities with sufficient data, mean monthly facility-level wastage rates were between 18 and 35% across all reviewed vaccines, with little difference between lyophilized and liquid vaccines. Most (98%) vaccinators believed high wastage led to recent vaccine stockouts, yet only 55% were familiar with the multi-dose vial policy for minimizing wastage. On average, vaccinators reported that a minimum of six children must be present prior to opening a 10-dose MCV vial. Third dose of diphtheria-tetanus-pertussis vaccine (DTP3) was administered in 84% of sessions and MCV in 63%; however, the number of MCV and DTP3 doses administered were similar indicating the number of children vaccinated with DTP3 and MCV were similar despite less frequent MCV vaccination opportunities. Among caregivers, 30% reported being turned away for vaccination at least once; 53% of these children had not yet received the missed dose.

DISCUSSION:

Our findings show inadequate implementation of vaccine management guidelines, missed opportunities to vaccinate, and lyophilized vaccine wastage rates below expected rates. Missed opportunities for vaccination may occur due to how the health system's contradicting policies may force health workers to prioritize reduced wastage rates over vaccine administration, particularly for multi-dose vials.

WEB: [10.1016/j.vaccine.2017.09.082](https://doi.org/10.1016/j.vaccine.2017.09.082)

IMPACT FACTOR: 3.41

CITED HALF-LIFE: 5.90

START EDITORIAL COMMENT: Although wastage rates were found to be lower than expected (18% – 35% across vaccines in six months), there were missed opportunities for vaccination (30% of caregivers were turned away at least once) due to such factors as the need to wait for at least six children before opening measles-containing vaccine. The study suggests that there is a need for clarity in policy as it pertains to the balance between vaccine wastage and missed opportunities for vaccination in Nigeria and similar countries.

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APPENDIX

(((((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]) ("2017/11/15"[PDAT] : "2017/12/14"[PDAT]))

* December 30, 2017, this search of English language articles published between November 15, 2017 and December 14, 2017 and indexed by the US National Library of Medicine resulted in 215 unique manuscripts.

