DPCP
DOSE PER CONTAINER PARTNERSHIP

DPCP SNAPSHOT

SENEGAL: WEIGHING THE COSTS AND BENEFITS OF CHANGING DPC

Vaccines for low- and middle-income countries have traditionally been procured in multi-dose containers of 10 or 20 doses. However, vaccines in single or low-dose presentations offer potential advantages such as reduced wastage and increased access that must be weighed against potential disadvantages such as higher costs and supply chain and cold chain capacity requirements. Research by the Dose Per Container Partnership (DPCP) in Senegal examined the relationship between dose per container (DPC) for the vaccines in the Senegalese Expanded Programme on Immunization (EPI) and tradeoffs in terms of wastage, cost, coverage, timeliness, safety, health care worker (HCW) behavior, and supply chain and cold chain effects. The key findings include:

1. HCWs and managers took DPC into account when planning and implementing the immunization program; and HCWs employed a range of "work-around" strategies with multi-dose presentations to reduce wastage and increase coverage.
2. High DPC vaccines such as 5, 10, or 20 that could be kept for up to 28 days after opening[1] in Senegal had similar vaccine wastage rates to single-dose presentations in countries that use the multi-dose vial policy; thus higher DPC does not necessarily translate to more wastage possibly due to the work-arounds.
3. Reducing DPC of more expensive vaccines may reduce overall costs. An economic analysis of three multi-dose vaccines with 6-hour viability after opening showed that for two vaccines, switching to a lower DPC may not yield economic benefits, because savings from reduced wastage may not outweigh the higher price per dose; but for one more expensive vaccine, lower DPC could reduce overall costs.

THE TAKEAWAY

Senegal's vaccine program is achieving high coverage[2] while using existing practices largely based on HCW work-around strategies such as scheduling sessions so that there are more kids present when they open a vial to reduce wastage and reach national targets. Each vaccine must be examined individually when selecting the optimum DPC for meeting national targets, taking into consideration the delivery contexts and tradeoffs in terms of wastage, coverage, safety, and costs.

DPCP: EXAMINING THE EFFECTS OF MULTIDOSE VACCINE PRESENTATIONS

The widespread use of multi-dose vaccine containers in low- and middle-income countries' immunization programs is assumed to offer benefits and efficiencies for health systems, such as reducing the purchase price per vaccine dose and easing cold chain requirements. Yet the broader impacts on immunization coverage, costs, and safety are not well understood. It is also unclear what processes governments typically go through to determine their choices about DPC, and what information decision-makers have or use when determining DPC.

To add to the limited evidence base on this topic, the Dose Per Container Partnership, or DPCP, is undertaking a series of activities to explore current decision-making on DPC options and better understand the relationship between DPC and immunization systems, including operational costs, timely coverage, safety, product costs/wastage, and policy/correct use.

1 See World Health Organization (WHO). 2014. WHO Policy Statement: Multi-Dose Vial Policy (MDVP): Revision 2014, available at apps.who.int/iris/bitstream/10665/135972/1/WHO_IVB_14.07_eng.pdf?ua=1

2 2016 WHO National Senegal penta and rota coverage rate both estimated at 93%

Trade-offs in Multiple-Dose Presentation

The DPCP seeks to better understand how changes in DPC could affect other components of immunization programs:

COVERAGE RATES *including timeliness*

WASTAGE RATES

SAFETY

COSTS PER DOSE *and child vaccinated*

SUPPLY CHAIN

HCW BEHAVIOR *including willingness to open a multidose vial no matter how many children present*

THE RESEARCH

In July 2017, the DPCP conducted formative research in two regions of Senegal to examine: 1) the relationships between DPC and vaccine wastage, coverage, session frequency, timeliness, safety, and costs; and 2) HCWs' knowledge, behavior, and preferences related to DPC. The research, conducted at 60 health facilities, entailed observation of HCW practices; analysis of immunization registry data for 601 children; a costing survey; and interviews of 69 immunization staff from health facility, district, regional, and national levels. The work focused on vaccines included in the Senegal routine EPI schedule: DTP-Hep B-Hib (pentavalent), bacillus Calmette-Guérin (BCG), inactivated polio virus (IPV), oral polio vaccine (OPV), pneumococcal conjugate vaccine (PCV), measles-rubella (MR), rotavirus, and yellow fever (YF) vaccines.

Coverage: Overall coverage in the target districts was fairly high though below the national averages,[3] and the analysis could not determine whether DPC had an effect on coverage. Fifty-seven of the facility-based HCWs said that coverage was more important than wastage for measuring facility performance though 47 of those 60 said that wastage rates also affected facility performance evaluations. Officially, immunization coverage targets are 90 percent for all vaccines; when asked, study participants cited either 80 or 90 percent as the target.

Wastage: Average wastage rates varied from 6 percent (PCV, in a one-dose vial) to 40 percent (BCG, in a 20-dose vial—though this vaccine had the highest coverage rate). Most participating facilities offered some vaccines less frequently (i.e., those that must be discarded after six hours of opening), as a way to reduce wastage. Due to various strategies to ensure coverage (see next section), these facilities achieved decent coverage levels even for these vaccines that were offered less frequently. Vaccines like Hep B, IPV, OPV, and pentavalent, which can be stored for 28 days after opening a vial, were offered more frequently and had lower wastage rates.

Providers' decisions on opening vials: The HCWs were asked how many children needed to be present to open multi-dose vials.[4] For BCG, which comes in 20-dose vials, half said 10 children must be present. For MR and YF (both in 10-dose vials and must be discarded 6 hours after opening), a majority specified five children.

Reaching coverage targets: HCWs said that they used various strategies, both at the facility and with parents and the community, to ensure that children are vaccinated. These included making appointments, contacting caregivers directly, collaborating with community health workers, going door to door through community mobilization, and registering all births to ensure follow-up. HCWs also said that facilities conduct fixed sessions: 1–2 times monthly (13 facilities), 1–2 times weekly (21 facilities), or daily (25 facilities).

HCWs' preference on presentation: Approximately half of respondents at all levels expressed a preference for a single-dose vial of BCG while some preferred a 5-dose vial and others preferred a 10-dose vial (see Table 1). Overwhelmingly, respondents preferred lower-DPC presentations to reduce wastage. However, 20 respondents at all levels mentioned that lower-DPC presentations could lead to challenges with storage, and an increase in the number of vials requiring collection. Two respondents cited the risk of stockouts, and one associated the risk with insufficient storage capacity.

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3 In Louga and Ziguinchor, where the research took place, coverage was lower than the national average, according to the 2015 District Vaccination Data Management Tool. In Louga, coverage for BCG, penta (third dose), and MR (first dose) was 79%, 73%, and 71%, respectively; for Ziguinchor, coverage was 67%, 68%, and 69%.

4 This question was not asked for vaccines available in single-dose vial (PCV and rotavirus), or for vaccines other than IPV that are eligible for 28-day storage after opening (Hep B, pentavalent, and OPV).

TABLE 1. EXPRESSED PREFERENCE FOR DOSE(S) PER CONTAINER PRESENTATION; COMBINED RESULTS FROM HEALTH FACILITY, DISTRICT, REGIONAL, AND NATIONAL LEVELS

Vaccine[a]	Current DPC	Liquid or lyophilized	Respondents preferring a different number of DPC (n = 69)	New DPC preferred		
				1 DPC	5 DPC	10 DPC
BCG	20	Lyophilized	69	35	21	13
Measles-rubella	10	Lyophilized	59	28	31	0
Yellow fever	10	Lyophilized	59	28	31	0
Hep B	10	Liquid with preservative	26	17	9	0
IPV	5	Liquid with preservative	21	21	0	0
Pentavalent	10	Liquid with preservative	17	13	4	0
OPV	10	Liquid with preservative	13	9	4	0
PCV	1	Liquid, no preservative	1	0	0	1

a. No respondent expressed a preference for a different presentation of rotavirus vaccine.

Abbreviations: BCG, bacillus Calmette–Guérin; DPC, doses per container; Hep B, hepatitis B; IPV, inactivated polio vaccine; OPV, oral polio vaccine; PCV, pneumococcal conjugate vaccine.

Timeliness: Interviewees said that timeliness of vaccinations was a frequent topic during facility meetings. Timeliness[5] varied by vaccine and was influenced by presentation. According to a review of administrative records, sixty percent of children were vaccinated with Hep B on time (within 72 hours of birth), and 77 percent of those vaccinated with BCG birth dose vaccines received them within 30 days of birth. For penta, MR, and YF, the proportion of timely vaccinations was similar to that of Hep B and BCG birth doses (51%, 64%, and 63%, respectively, for records observed). HCWs reported using the same strategies to enhance timeliness that they used to ensure coverage—focusing on increasing caregivers' awareness to encourage timely vaccination.

Safety: Overall, vaccine handling practices were good. Researchers used a checklist on first page key finding 1* and observed 752 injections administered to 452 children in sessions with between 2 and 53 children. Only 13 minor vaccine handling violations were noted in 11 facilities. These included: vials in use not refrigerated; not discarding syringes in a safety box until after the session; using the same reconstitution syringe for different vaccines or not immediately discarding the reconstitution syringe; leaving syringes in the vial septum after filling; and having open vials in the refrigerator (though these were likely within the six-hour time limit as the HCW stated that she moves them to refrigerated storage when children are not present for vaccination).

Facility costs: The average yearly cost for cold chain, transport, outreach, human resources, and waste disposal was estimated at USD$4,828 per health facility—but ranged from under $3,000 on average (for a facility targeting 141 children annually) to over $6,000 (for facilities with an EPI target of more than 365 children annually). Human resources represented the largest share of these operational costs. Vaccine procurement costs represented the largest share of overall facilities' costs. The DPCP's analysis estimated that each facility used an average of about 4,900 doses of vaccine over 12 months. The annual average value of vaccines and supplies was $6,239. The average annual wastage costs were $615, with 36 percent of these costs attributable to vaccines available in multi-dose presentations that must be discarded after six hours.

Factors in vaccine wastage: Wastage rates were complex (see Table 2) and depended on several variables. The highest wastage was for BCG vaccine (40%) which comes in a 20-dose vial and must be discarded six hours after opening. PCV and YF had the highest dollar value for vaccines wasted. Higher doses per vial did not necessarily correlate to higher wastage rates.

5 Different time periods are used to define timeliness for different vaccines so it's difficult to compare across vaccines

* marked on page 1

TABLE 2. AVERAGE VACCINE UTILIZATION VALUE PER HEALTH FACILITY AND WASTAGE AND COVERAGE RATES FOR THE HEALTH FACILITIES INCLUDED IN THE SAMPLE OVER A 12-MONTH PERIOD

	BCG	OPV	IPV	Hep B	Penta	PCV	Rota	YF	MR
Total value of vaccines used (administered and wasted)	$38	$149	$291	$51	$625	$2,569	$1,522	$417	$330
Value of vaccines administered	$23	$129	$227	$34	$580	$2,427	$1,415	$278	$264
Value of vaccines wasted	$15	$19	$64	$17	$45	$142	$107	$139	$66
Estimated wastage rate	40%	13%	22%	34%	7%	6%	7%	33%	20%
Estimated coverage rate	103%	87%	42%	67%	87%	88%	88%	81%	87%

Abbreviations: BCG, bacillus Calmette–Guérin (vaccine); Hep B, hepatitis B (vaccine); IPV, inactivated polio vaccine; MR, measles-rubella (vaccine); OPV, oral polio vaccine; PCV, pneumococcal conjugate vaccine; Penta, pentavalent (vaccine); Rota, rotavirus (vaccine); YF, yellow fever (vaccine).

- The vaccines with the lowest average wastage rates were PCV (6%), rotavirus (7%), and pentavalent (7%). The low wastage rates for PCV and rotavirus vaccines are not surprising because they are in single-dose containers. Pentavalent vaccine is in a 10-dose vial that can be kept for 28 days after opening; it is given on a three-dose schedule, and is being managed well from a wastage standpoint.

- Study data indicated that Hep B in 10-dose presentation had a high wastage rate (34%), but researchers believed that this may be due to inaccurate tracking, since the Hep B vaccine birth dose is not only given through the immunization program, but also in maternity wards.

- Wastage rates were higher for 10-dose vials of YF than 10-dose vials of MR (33% versus 20%, respectively), though the vaccines are co-administered. This may be because MR is given in a 2-dose schedule and YF in one, resulting in a larger session size for MR in most immunization sessions.

Impact of lower DPC on costs: DPCP analyzed the potential impact of reducing the DPC for BCG (from 20- to 10-DPC) and MR and YF (from 10- to 5-DPC). These are vaccines for which respondents preferred a lower DPC, and which are not always offered at each session in an attempt to reduce wastage. The findings showed that:

- For BCG and MR, reducing DPC may not yield economic benefits because the higher price per dose with the switch could lead to higher procurement costs, which might not compensate for potential savings due to reductions in wastage.
- For YF, which is more expensive than BCG and MR, a reduction of wastage of over 5 percent (the present rate is 33%) may result in cost savings.

The analysis showed limited impacts on costs for the supply chain and cold chain since most facilities currently had enough cold chain capacity to accommodate the estimated additional volume of lower DPC vaccines. Researchers believed that reducing DPC would have small impacts on transportation, waste disposal, and human resource costs, but this was not quantitatively evaluated.

This document was developed by JSI through the Dose Per Container Partnership (DPCP). The partnership is coordinated by JSI Research & Training Institute, Inc. in collaboration with colleagues from the Clinton Health Access Initiative, the HERMES modeling team and the International Vaccine Access Center (IVAC) through Johns Hopkins School of Public Health, and PATH. This material is intended to provide stakeholders evidence to guide informed, sustainable decisions on DPC when considering vaccine products and program design and may be used freely by all partners.