



# Assessment of vaccine wastage rates, missed opportunities, and related knowledge, attitudes and practices during introduction of a second dose of measles-containing vaccine into Cambodia's national immunization program



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## ABSTRACT

**Introduction:** Missed opportunities for vaccination (MOV) can result in inadequate protection against disease. Although healthcare provider reluctance to open multi-dose, lyophilized vaccine vials (particularly the measles-containing vaccine [MCV]) for every eligible child due to concerns about wasting vaccine is a known reason for MOV, little is known about providers' related attitudes and practices.

**Methods:** In 100 randomly selected health facilities and 24 districts of Cambodia, we surveyed healthcare providers and their district supervisors regarding routine vaccine administration and wastage knowledge and practices, and child caregivers (five per facility) regarding MOV. Vaccine stock management data covering six months were reviewed to calculate facility and district level wastage rates and vaccine usage patterns for six vaccines, including a recently introduced second dose of MCV (MCV2).

**Results:** Response rates were 100/100 (100%) among facility staff, 48/48 (100%) among district staff, and 436/500 (87%) among caregivers. Mean facility-level wastage rates varied from 4% for single-dose diphtheria-tetanus-pertussis-hepatitis B-Haemophilus influenzae type b vaccine to 60% for 10-dose MCV; district-level wastage rates for all vaccines were 0%. Some vaccines had lower wastage rates in large facilities compared to small facilities. The mean MCV wastage rate was the same before and immediately after MCV2 introduction. Providers reported waiting for a mean of two children prior to opening an MCV vial, and 71% of providers reported offering MCV vaccination less frequently during scheduled vaccination sessions than other vaccines. Less than 5% of caregivers reported that their child had been turned away for vaccination, most frequently (65%) for MCV.

**Discussion:** Although the MCV wastage rate in our study was in line with national targets, providers reported waiting for more than one child before opening an MCV vial, contrary to vaccine management guidelines. Future research should explore the causal links between provider practices related to vaccine wastage and their impact on vaccination coverage.

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## 1. Introduction

Since the beginning of the Expanded Program on Immunization (EPI) in 1974, an important strategy for reaching high immunization coverage is ensuring eligible individuals are vaccinated at every opportunity [1]. Missed opportunities for vaccination

(MOV) occur when a vaccination-eligible individual interacts with a healthcare provider for any type of healthcare visit (preventative or curative care) but is not vaccinated. MOV can occur due to a wide range of issues related to both healthcare provider and caregiver knowledge, beliefs and practices [2,3]. For instance, MOV have been associated with providers' reluctance to open multi-dose vials of lyophilized vaccines, including measles-containing vaccine (MCV) and Bacillus Calmette–Guérin (BCG) vaccine, which must be discarded six hours after reconstitution or at the end of a

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vaccination session (whichever comes first), per World Health Organization (WHO) recommendations. Provider reluctance to open multi-dose vials when only one child or a few children are present may stem from concerns about incurring high vaccine wastage rates, but few studies have examined such provider behavior in depth.

Vaccine wastage is generally defined as the proportion of doses discarded in opened or unopened vaccine vials that are not used to vaccinate an eligible individual [4]. Generally, countries use a single nationwide estimated wastage rate per vaccine for forecasting national vaccine need and as a benchmark for monitoring wastage [5]. The WHO provides wastage-related guidance, including avoidable and unavoidable reasons for discarding vaccine. Doses discarded from an opened lyophilized vaccine vial at the end of a vaccination session are considered unavoidable wastage. Globally, recommended maximum wastage rates for multi-dose vials of preserved lyophilized vaccines range from 30 to 50% versus 5–10% for preserved liquid vaccines, since the latter type of vaccine can generally be re-used up to 28 days after opening per the WHO multi-dose vial policy (MDVP) [6]. However, some evidence indicates that these global wastage recommendations can sometimes result in healthcare providers being reluctant to open a multi-dose MCV vial for only one child or a few children due to concern about wasting a high number of doses [7–9].

Concerns about high vaccine wastage stem largely from the costs associated with discarding unused vaccine. Recent modeling analyses have examined potential ways to address wastage by modifying vaccine supply chain practices and other assumed determinants; however the models have relied heavily on assumptions due to lack of empirical data on the factors that drive wastage rates at health facility level [10–13]. Assumed determinants of wastage include size of a facility's target population, number of children expected per vaccination session, number of doses in a vial and type of vaccine. These assumptions may be better informed by empirical data about how well providers in a variety of low and lower-middle income country settings adhere to vaccine wastage-related policies. Another concern about wastage is the potential for children to be turned away for vaccination due to healthcare providers' attempts to reduce vaccine wastage, leading to a negative effect on vaccination coverage levels and ultimately increasing the programmatic cost of vaccinating each child from both health sector and societal perspectives. Lastly, countries may benefit from a better understanding of wastage rates and the factors that drive these rates by applying this information to improve vaccine forecasting approaches. For instance, countries often use a single wastage rate for each vaccine when forecasting vaccine need; however, it may be unsuitable to apply a single rate to all areas of a country if results indicate certain operational factors (such as population density) can influence wastage rates and subsequent vaccine supply needs.

In mid-2012, Cambodia's National Immunization Program (NIP) began a rolling introduction of the second dose of measles-containing vaccine (MCV2) and initiated preparations to transition away from subsidized vaccine purchasing through external partner funding in the near future. Vaccination coverage in Cambodia is among the highest of all low and lower-middle income countries (>85% for most vaccines in 2011 when this study occurred). In Cambodia, hepatitis B and pentavalent (diphtheria-tetanus-pertussis-hepatitis B-*Haemophilus influenzae* type b) vaccines are in 1 dose vial presentations, oral polio, MCV and tetanus toxoid vaccines are in 10 dose vial presentations, and BCG vaccine is in a 20-dose vial presentation. Aiming to maintain high coverage and contain vaccine costs, the Cambodia NIP expressed interest in examining vaccine wastage rates and associated provider knowledge and practices. To do so, CDC and WHO assisted the NIP to evaluate vaccine wastage rates at the health facility (where routine vaccination sessions occur)

**Table 1**  
Mean monthly vaccine wastage rates in 100 health centers; Cambodia, July–December 2012.

Vaccine and timeframe given (n = number of facility-months <sup>a</sup> analyzed)	Type	Doses in series	Doses in vial	National target maximum wastage rate <sup>e</sup>	Total wastage rate, mean % (95% CI)	Total wastage rate in large <sup>b</sup> health centers, mean % (95% CI)	Total wastage rate in small <sup>b</sup> health centers, mean % (95% CI)	Open vial wastage rate, mean % (95% CI)
<b>Birth</b>								
hepatitis B (n = 378)	Liquid	1	1	0	6 (5, 8)	1 (0, 1)	6 (5, 8)	1 (1, 2)
BCG (n = 492)	Lyophilized <sup>e</sup>	1	20	75	81 (79, 82)	75 (72, 79)	81 (80, 82)	78 (77, 80)
<b>Childhood</b>								
pentavalent (n = 420)	Liquid	3	1	0	4 (2, 5)	1 (0, 2)	4 (2, 5)	1 (0, 1)
polio (n = 390)	Liquid	3	10	25	25 (23, 27)	13 (6, 21)	25 (23, 27)	22 (20, 24)
MCV (n = 492)	Lyophilized	2 <sup>f</sup>	10	50	60 (57, 62)	45 (33, 57)	60 (57, 62)	56 (54, 58)
MCV, pre-MCV2 <sup>c</sup> (n = 45)	Lyophilized	2 <sup>f</sup>	10	50	60 (54, 67)	NA <sup>d</sup>	62 (56, 68)	59 (52, 66)
MCV, post-MCV2 <sup>c</sup> (n = 405)	Lyophilized	2 <sup>f</sup>	10	50	58 (56, 61)	53 (48, 58)	61 (58, 63)	56 (54, 58)
<b>Maternal</b>								
tetanus toxoid (n = 372)	Liquid	5	10	25	27 (25, 30)	14 (8, 21)	27 (25, 30)	23 (20, 25)

Definitions: CI = confidence interval; BCG = bacille Calmette-Guérin vaccine; MCV = Measles-containing vaccine; MCV2 = Measles-containing vaccine, second dose; pentavalent = diphtheria-tetanus-pertussis-hepatitis B-*Haemophilus influenzae* type b vaccine; open vial wastage = waste of vaccine that occurs after a vial has been opened for use; total wastage = sum of open and unopened vaccine wastage.

<sup>a</sup> Facility months = 6 months of vaccine stock records were abstracted from each health center for a total target of 600 facility-months of records; some monthly records for certain vaccines were excluded due to data inconsistencies.

<sup>b</sup> Large health center defined as serving an estimated under one-year old population > 1000 (mean size = 1173); small health center defined as serving an estimated under one-year old population of ≤ 1000 (mean size = 305).

<sup>c</sup> Pre-MCV2 is during the period prior to MCV2 introduction and post-MCV2 is after MCV2 introduction.

<sup>d</sup> Not applicable: All large health facilities had introduced MCV2 by the start of this study's data review period so no pre-MCV2 data were collected.

<sup>e</sup> Rate used by country for forecasting vaccine need and provided to health sector for performance monitoring purposes.

<sup>f</sup> Cambodia began a rolling introduction of a second routine dose of measles-containing vaccine throughout the 2nd half of 2012, completed by end of April 2013.

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