

Assessment of vaccine wastage rates and wastage factor and causes of wastage in selected Health Care Centres of East Khasi Hills, Meghalaya

¹M Kimdingdii, College of Nursing, NEIGRIHMS, Shillong, Meghalaya, 793018

²Ms. Nochovono Tase, College of Nursing, NEIGRIHMS, Shillong, Meghalaya, 793018

²Ms. Jodibala Haobijam, College of Nursing, NEIGRIHMS, Shillong, Meghalaya, 793018

Corresponding Author: M Kimdingdii, College of Nursing, NEIGRIHMS, Shillong, Meghalaya, 793018

Citation this Article: M Kimdingdii, Ms. Nochovono Tase, Ms. Jodibala Haobijam, “Assessment of vaccine wastage rates and wastage factor and causes of wastage in selected Health Care Centres of East Khasi Hills, Meghalaya”, IJMSIR- April - 2022, Vol – 7, Issue - 2, P. No. 321 – 330.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction: Vaccination is a cost-effective and life saving intervention. Many factors influence the vaccine wastage including type of vaccines and immunization practices. The WHO reports over 50% vaccine wastage around the world (2005). The MoHFW, GoI recommends wastage rates of 50% (wastage factor: 2.0) for BCG vaccine, 25% (wastage factor: 1.33) for MR and JE vaccines and 10% (wastage factor: 1.11) for IPV, OPV, DPT, TD, Pentavalent, Hepatitis B and Rotavirus vaccines (2019)⁽¹⁹⁾.

Methods: A cross sectional study was conducted on 62 participants and 15 selected Urban Health Care Centres using total enumerative sampling technique in March and July 2021. Data was collected with a semi-structured questionnaire to assess the causes of wastage and WHO Vaccine Wastage Report Form to assess the vaccine wastage rate and wastage factor. Descriptive statistics and WHO formulas to calculate vaccine wastage were used for data analysis.

Results: The reported highest wastage rates and wastage factor for BCG, MR, JE, RVV, OPV, IPV, TD, DPT and

Pentavalent vaccines were 92.8% (14), 74.80% (3.9), 53.90% (2.1), 70% (3.3), 63.4% (2.7), 86.54% (7.4), 57.80% (2.30), 56.10% (2.2), 56% (2.2) respectively. The cause of BCG, MR and JE vaccine wastage was due to less number of beneficiaries (66.12%, 53.22%, 43.54%) while the causes of wastage for OPV, IPV, TD, DPT, Pentavalent vaccines were VVM reached discard point (37.09%), vaccine vial crossing 28 days since the date of opening (80.64%), less number of children and pregnant women (43.54%) and less number of children for booster doses (41.93%). The highest reported lyophilized, liquid, oral and injectable vaccine wastage were 69.7% (3.3), 60.3% (2.5), 56.7% (2.3) and 57.99% (2.3). The reported wastage for 5, 10, 20 and 25 dose vials were 54.6% (2.2), 52.7% (2.1), 63.4% (2.7) and 86.6% (7.4) respectively.

Conclusion: Most of the centres reported high wastage for vaccines namely BCG, MR and JE. The causes of the vaccine wastage were less number of beneficiaries, VVM reached discard point, loss of doses during administration. Thus, there is a need for use of smaller vaccine presentations (vial doses) that results in less vaccine wastage, periodic training and assessment of

vaccine management practices of nurses at the community level.

Key words: Vaccine wastage rates, vaccine wastage factor, causes of wastage, Urban Health Centres

Introduction

Vaccination is a cost-effective and lifesaving intervention. Monitoring vaccine wastage helps to improve vaccine forecasting and minimise wastage. A number of factors influence the vaccine wastage including type of vaccines, syringes, immunization practices and policies.⁽¹⁾ The World Health Organization reports over 50% vaccine wastage around the world (2005). Vaccine wastage is expected in all vaccination programmes. Accurately calculating vaccine wastage rate and ensuring wastage is minimized without jeopardizing immunization coverage is key. Vaccine wastage is the sum of vaccines discarded, lost, damaged or destroyed⁽³⁾. WHO recommends that vaccines be administered every time an eligible child presents for vaccination irrespective of the total number of children present for the particular vaccine in the vaccination facility? The MoHFW, GoI recommends wastage rates of 50% (wastage factor: 2.0) for BCG vaccine, 25% (wastage factor: 1.33) for MR and JE vaccines and 10% (wastage factor: 1.11) for IPV, OPV, DPT, TD, Pentavalent, Hepatitis B and Rotavirus vaccines (2019)⁽¹⁹⁾. Regular supply, proper management and monitoring, tracking of unimmunized child, ensuring complete immunization and expanding the immunization coverage in low vaccination performance areas are very important for the success of immunization programmes⁽¹⁴⁾.

Methodology

Study Design: A descriptive cross-sectional research study.

Setting: The study was conducted in selected Urban Health Care Centres of East Khasi Hills, Meghalaya.

Study population and study period: A total of 15 Urban Health Care Centres and 62 participants were selected in the study using total enumerative sampling technique and data was collected from 1st to 27th March 2021 and 26th to 30th July 2021.

Data retrieval and analysis: The data was retrieved for a three-month period from December 2020 to February 2021 from immunization records, maternal child health and vaccine stock registers using a structured tool to assess the vaccine wastage rates and wastage factor and a semi-structured questionnaire was administered among the participants to assess the causes of vaccine wastage. Data was analyzed using formulas for calculating vaccine wastage rate and wastage factor and descriptive statistics (Frequency and Percentage).

Results

Wastage rate and wastage factor for different vaccines

The reported highest wastage rates and wastage factor for BCG, MR, JE, RVV, OPV, IPV, TD, DPT and Pentavalent vaccines were 92.8% (14), 74.80% (3.9), 53.90% (2.1), 70% (3.3), 63.4% (2.7), 86.54% (7.4), 57.80% (2.30), 56.10% (2.2), 56% (2.2) respectively. The lowest wastage rate and wastage factor reported for BCG, MR, JE, RVV, OPV, IPV, TD, DPT and Pentavalent vaccines were 80% (5.0), 51.30% (2.05), 16.30% (1.19), 3.10% (1.03), 2.90% (1.02), 0.90% (1.0), 3.50% (1.03), 2.60% (1.02) and 1.0% (1.0) respectively.

Fig 1: Bar diagram showing the main causes of vaccine wastage for different vaccines N= 62.

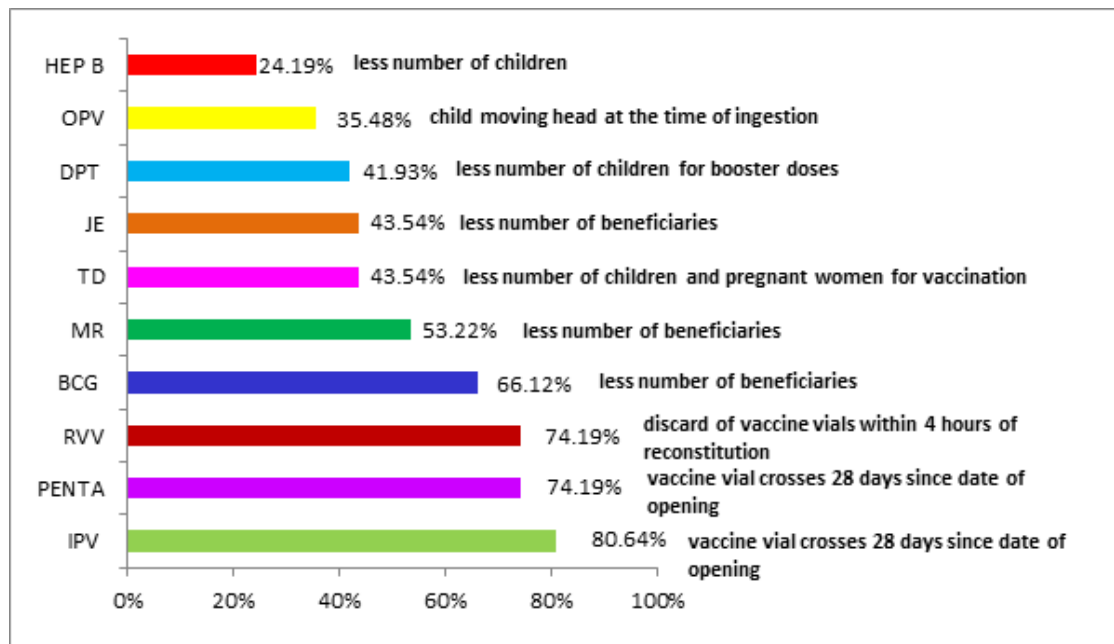


Fig 2: Bar diagram showing reasons for discard of all vaccine vials and vaccine vials with VVM

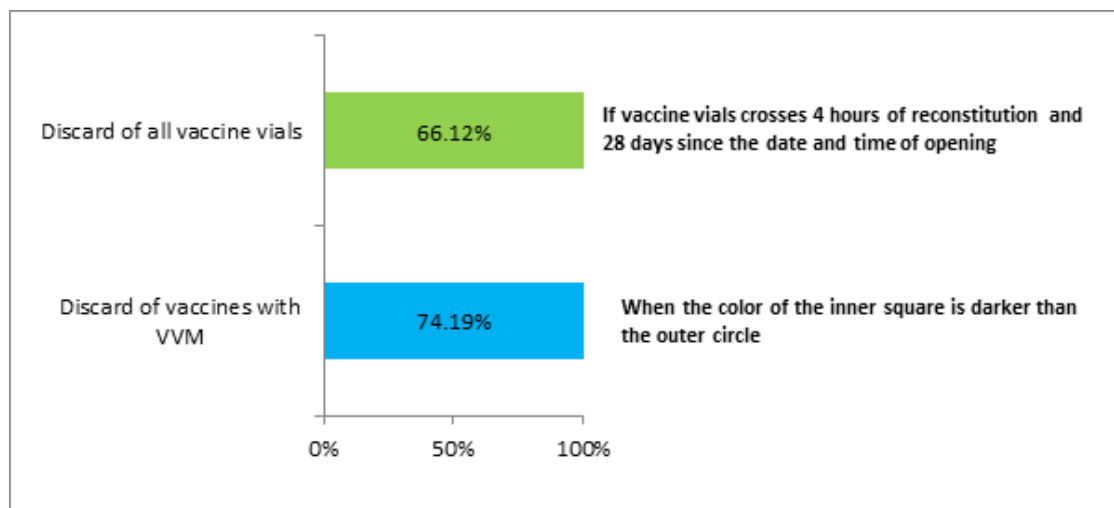


Table 1: Vaccine wastage across form/type of vaccine N= 15

Health care centres	Liquid vaccine		Lyophilized vaccine	
	Wastage rate (%)	Wastage factor (WF)	Wastage rate (%)	Wastage factor (WF)
Centre 1	42.93%	1.75	52.6%	2.10
Centre 2	33.2%	1.4	52.2%	2.09
Centre 3	56.4%	2.2	49.2%	1.9
Centre 4	17.6%	1.2	60.0%	2.5
Centre 5	4.5%	1.0	53.3%	2.1
Centre 6	43.75%	1.70	55.9%	2.2

Centre 7	035.6%	01.5	48.5%	01.9
Centre 8	026.5%	01.3	51.6%	02.0
Centre 9	060.3%	02.5	44.5%	01.8
Centre 10	024.1%	01.3	69.7%	03.3
Centre 11	044.8%	01.8	63.2%	02.7
Centre 12	026.3%	01.3	42.8%	01.7

Fig 3: Bar diagram showing vaccine wastage rates for lyophilized and liquid vaccines N= 15

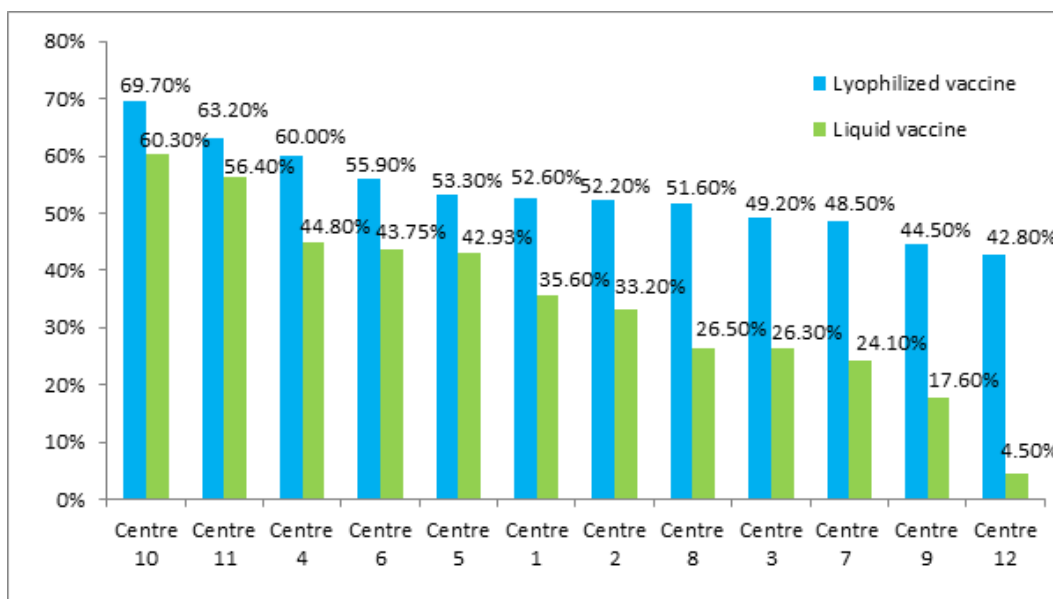


Table 2: Vaccine wastage according to doses per vial wastage N=15

Health care centres	5 dose vial		10 dose vial		20 dose vial		25 dose vial	
	Wastage rate (%)	Wastage factor (WF)	Wastage rate (%)	Wastage factor (WF)	Wastage Rate (%)	Wastage factor (WF)	Wastage rate (%)	Wastage factor (WF)
Centre 1	45.95%	1.8	36.5%	1.5	11.4%	1.1	37.1%	1.5
Centre 2	40%	1.6	40.9%	1.6	26.3%	1.3	50.8%	2
Centre 3	54.6%	2.2	51.5%	2.0	38.3%	1.6	74.1%	3.8
Centre 4	31.5%	1.4	29.6%	1.4	28.2%	1.3	32.8%	1.4
Centre 5	25.4%	1.3	29.4%	1.4	2.9%	1.0	0.9%	1.0
Centre 6	22.6%	1.2	41.6%	1.7	48.7%	1.9	57.7%	2.3
Centre 7	37.0%	1.5	25.6%	1.3	39.9%	1.6	4.9%	1.0
Centre 8	28.8%	1.4	38.8%	1.6	19.3%	1.2	51.1%	2.0
Centre 9	35.6%	1.5	49.1%	1.9	63.4%	2.7	86.6%	7.4

Centre 10	038.5%	1.6	52.7%	2.1	33.9%	1.5	16.5%	1.1
Centre 11	029.8%	1.4	37.4%	1.5	02.9%	1.0	0%	1.0
Centre 12	022.6%	1.2	34.8%	1.5	30.6%	1.4	16.75%	1.2

Table 3: Vaccine wastage according to mode of administration N= 15

Health care centres	Oral		Injectable	
	Wastage rate (%)	Wastage factor (WF)	Wastage rate (%)	Wastage factor (WF)
Centre 1	033.6%	1.5	040.6%	1.6
Centre 2	34.85%	1.5	041.3%	1.7
Centre 3	056.4%	2.2	53%	2.1
Centre 4	022.3%	1.2	033.7%	1.5
Centre 5	007.1%	1.0	027.4%	1.3
Centre 6	034.1%	1.5	045.4%	1.8
Centre 7	039.8%	1.6	025.9%	1.3
Centre 8	020.7%	1.2	040.2%	1.6
Centre 9	056.7%	2.3	57.99%	2.3
Centre 10	30%	1.4	048.3%	1.9
Centre 11	010.1%	1.1	033.3%	1.4
Centre 12	029.8%	1.4	029.6%	1.4

Discussion

The findings of present study results were discussed in relation to the objectives of the study conducted and this was compared to the results of similar studies in the area of research.

Vaccine wastage is divided into two categories namely wastage in unopened vials and wastage in open vials. Wastage in unopened vials may be caused by expiration, missing inventory, thermo-instability, freezing and breakage of the vaccine vials. Opened vial wastage may be because of improper reconstitution of the vaccines, discarding remaining doses at end of vaccination session, vaccine vial submerged in water during storage, suspected contamination, faulty vaccination technique. Assessing the vaccine wastage helps in forecasting vaccine requirements which will help in reducing

wastage of vaccines⁽¹³⁾. In this study the objectives were to assess the wastage rates, wastage factor and causes of wastage in selected Health Care Centres of East Khasi Hills, Meghalaya.

Findings on vaccine wastage rate for different vaccines

In the present study, the highest wastage rate was 92.80% for BCG vaccine followed by 74.8% highest wastage rate for MR vaccine which was partially supported by Wallace et.al reported wastage rate of 81% for BCG vaccine and 60% for MCV vaccine⁽⁸⁾. The present study reported that MR vaccine showed 74.5 % highest wastage rate and lowest wastage rate of 51.3% and can be correlated to studies by Chakraborty N et.al, Gupta V et.al and Pallanivel C et.al where the reported wastage rates for MR were 56.5%, 41.28% and 39.9%^(6,7,9).

In the present study the highest reported wastage rate of JE vaccine was 53.90% and the lowest wastage rate was 16.30% while Chakraborty N et.al reported a wastage rate of 45.1% for JE vaccine. The present study reported 50% highest wastage rate for RVV while Usuf et.al reported a lower wastage rate of 5.2% for RVV⁽¹⁾. In the present study, OPV showed the highest wastage rate of 63.4% and lowest wastage rate of 2.90% while Sharma G et.al, Patle L et.al and Daya P et.al reported lower OPV wastage rates of 29.45%, 12.63% and 2.4% respectively^(12,15,16).

The present study reported the highest wastage rate of 86.54% for IPV while lower wastage rates of 33.1%, 10.49% and 5.1% were reported by Chakraborty N et.al, Tiwari R et.al and Usuf et.al for IPV^(1,7,11). For TD vaccine, the present study reported highest wastage rate of 57.80% and lowest wastage rate of 3.50%. The study findings were consistent with studies by Pallanivel C et.al, Chakraborty N et.al, Gupta V et.al, Patle L et.al and Tiwari R et.al reported TT wastage rates of 62.8%, 57.6% 36.81%, 22.57% and 7.09%^(6,7,9,11,15).

The reported the highest wastage rate for DPT vaccine was 56.10% and the lowest wastage rate was 2.60% while Chakraborty N et.al reported a higher wastage rate of 65.4% for DPT vaccine than the present study⁽⁷⁾. The present study reported highest wastage rate of 56% for Pentavalent vaccine and the lowest wastage rate of 1% which correlates to studies by Chakraborty N et.al, Patle L et.al and Sharma G et.al with reported wastage rates of 38.6%, 33.8% and 9.39% for Pentavalent vaccine^(7,12,15).

Findings on vaccine wastage factor for different vaccines

The present study findings for BCG vaccine reported highest wastage factor of 14 which was higher than the recommended wastage factor of 1.33^(6,11,16). Studies by

Gupta V et.al, Pallanivel C et.al, Chakraborty N et.al, Patle L et.al, Mehta S et.al, Bagdey P et.al reported wastage factors of 4.52, 3.4, 3.21, 3.02, 1.83 and 1.53^(6,7,9,10,13,15) for BCG vaccine which were lower compared to the present study findings.

The present study reported the highest wastage factor of 3.9 for MR vaccine which was partially supported by Chakraborty N et.al where the wastage factor for MR vaccine was 2.28⁽⁷⁾. The present study reported the highest wastage factor of 2.1 and the lowest wastage factor of 1.19 for Japanese Encephalitis (JE) vaccine which was consistent to the reported wastage factor of 1.82 by Chakraborty N et.al⁽⁷⁾.

The present study showed the highest wastage factor of 3.3 and the lowest wastage factor of 1.03 for RVV vaccine. For OPV vaccine, the present study reported the highest wastage factor of 2.7 which was partially supported by studies by Sharma G et.al and Daya P et.al where the reported wastage factors for OPV vaccine were 1.42 and 1.02^(12,16). The present study reported the highest wastage factor of 7.4 and lowest wastage factor of 1.0 for Inactivated Polio (IPV) vaccine while the reported wastage factor of Chakraborty N et.al and Tiwari R et.al were 1.50 and 1.12 which were lower compared to the present study^(7,11).

The highest wastage factor for Tetanus Diphtheria (TD) vaccine was found to be 2.3 which was similar to the result of 2.3 wastage factor by Pallanivel et.al⁽⁹⁾. The highest reported wastage factor for Diphtheria Tetanus Pertussis (DPT) vaccine was 2.2 while Chakraborty N et.al reported a higher wastage factor of 2.90 compared to the present study. The highest reported wastage factor was 2.2 with lowest wastage factor of 1.0 for Pentavalent vaccine while Chakraborty N et.al and Patle et.al

reported wastage factor of 1.63 and 1.50 compared to the present study^(7,15).

Findings related to causes of vaccine wastage

In the present study, out of 62 total participants, 41 (66.12%), 33 (53.22%) and 27 (43.54%) responded that the causes of BCG, MR and JE vaccine wastage was due to less number of beneficiaries. Discarding vaccine within 4 hours of reconstitution was also the cause of JE, MR and BCG vaccine wastage as reported by 33 (53.22%), 28 (45.16%) and 15 (24.19%) participants. More number of institutional deliveries 3 (4.83%), exposure to sunlight 1 (1.61%) and defective vaccine vial 1 (1.61%) were also the causes of BCG, MR and JE vaccine wastage as reported by the participants. The study was partially supported by results of Usuf et.al (2016) where the wastage rate of 4.9% for BCG vaccine was due to breakage of vial and more than 90% of the wasted doses for lyophilized vaccines was due to discarding the remaining doses from open vials at the end of the immunization session and the other types of wastage recorded in unopened vials included missing inventory, VVM failure, breakage and use of wrong diluents. Wallace A et.al (2013) found that the main reason providers reported for vaccine wastage were discarding of BCG six hours after reconstitution (61%), vial breakage (31%) and exposure to high temperature (51%) which were similar to the findings of the present study^(1,8).

For Rotavirus vaccine wastage, the participants reported that vials had to be discarded within 4 hours of reconstitution 46 (74.19%), heat exposure 6 (9.67%), moving head at time of ingestion 5 (8.06%), loss of vaccine while opening vial 2 (3.22%) and loss of doses during administration 1 (1.61%) were the main causes of RVV wastage. Usuf et.al reported the wastage rate of

99.7% and 13% for RVV were due to expiry and missing vaccines⁽¹⁾. The present study found that the causes of OPV vaccine wastage were VVM reached discard point 23 (37.09%), child moving head at the time of ingestion 22 (35.48%), insufficient doses in vial 10 (16.12%), vaccine vial crosses 28 days since date of opening 5 (8.06%) and less beneficiaries 1 (1.61%) as reported by the participants. No wastage for OPV was reported by 1 (1.61%) participant. The study was partially supported by Usuf et.al where OPV showed wastage rate of 35.1% due to changes in VVM⁽¹⁾.

In the present study, 50 participants (80.64%) responded Inactivated polio vaccine (IPV) wastage was caused due to vaccine vial crossing 28 days since the date of opening while Usuf et.al also reported wastage rates of 5.7% due expiry of vaccine and change in VVM (2.2%) for IPV⁽¹⁾. The present study found that less number of children and pregnant women 27 (43.54%), vaccine vial crosses 28 days since date of opening 12 (19.35%), expiry of vaccine 9 (14.51%), VVM color change 8 (12.90%) and breakage of syringe/loss of administration 2 (3.22%) were the causes of TD vaccine wastage as responded by the participants. No wastage of TD vaccine was reported by 4 (6.45%) participants.

In the present study, 26 (41.93%) and 24 (38.70%) of the participants responded that less number of children for booster doses and vaccine vial crossing 28 days since the date of opening as the main causes for DPT vaccine wastage while 8 (12.90%) of the participants reported loss of doses during administration. Majority of the participants 46 (74.19%) responded that vaccine vial crosses 28 days since date of opening as the main cause of Pentavalent vaccine wastage. The other reported causes of wastage for Pentavalent vaccine were date and time not written in vial 8 (12.90%), change in color of

VVM 3 (4.83%), last dose does not amount to 0.5ml 1 (1.61%) and broken syringe 1 (1.61%) while no wastage was reported by 2 (3.22%) participants. The present study was partially supported by Usuf et.al where causes of Pentavalent vaccine wastage were due to expired doses (57.3%), breakage (83.3%) and missing vaccines (50%)⁽¹⁾.

The present study found that the main causes of Hepatitis B vaccine wastage were due to less number of children 15 (24.19%), more number of institutional deliveries 11 (17.74%), no supply 10 (16.12%), frozen vaccine 5 (8.06%) and no beneficiaries as facility was not a delivery point 4 (6.45%). The other reported causes of Hepatitis B vaccine wastage were vaccine not given in dispensary 4 (6.45%), expiry of vaccine 3 (4.83%), Hep B not used in routine immunization 3 (4.83%), the vaccine vial septum got submerged in water 2 (3.22%), vaccine vial crosses 28 days since date of opening 2 (3.22%), given in hospital after birth 1 (1.61%) and no deliveries 1 (1.61%) while no wastage was reported by 1 (1.61%) participant.

As for discarding of vaccines with Vaccine Vial Monitors (VVM), the present study found that out of 62 participants, 46 (74.19%) responded that vaccines with VVM should be discarded when the colour of the inner square is darker than the outer circle, when the inner square matches that of the outer circle 13 (20.96%), when vaccine vials have crossed date of expiry 2 (3.22%) and when vial is broken 1 (1.61%). Majority of the participants, 41 (66.12%) reported all vaccine vials should be discarded if vaccine vials cross 4 hrs of reconstitution and 28 days since the time and date of opening while 12 (19.35%) reported discarding if vaccine vials failed the "Shake test". The present study correlates with a study by Wallace et.al (Nigeria), where

participants reported that the list of reasons why wastage can happen were vial breakage (58%), discarding doses 6 hours after reconstitution (43%), vial exposure to high temperature (37%), vial spillage (57%) and inability to retrieve all doses from the vial (34%)⁽⁵⁾.

Findings on wastage rate and wastage factor for liquid and lyophilized vaccines

According to the WHO, the vaccine wastage rate for lyophilized vaccine is expected to be 50% wastage rate for 10-20 dose vials and 25% wastage rate for 10-20 dose vials for liquid vaccines⁽¹⁴⁾. The present study found the highest liquid vaccine wastage rate was 60.3% with wastage factor of 2.5 and the lowest liquid vaccine wastage rate was 4.5% with wastage factor of 1.0 while Pallanivel et.al and Chakraborty et.al reported wastage rate and wastage factor of 48.2% (1.9) and 41.3% (1.70) for liquid vaccines^(7,9,16).

The present study reported that for lyophilized vaccines, highest lyophilized vaccine wastage rate was 69.7% with wastage factor of 3.3 while the lowest lyophilized vaccine wastage rate was 42.8% with wastage factor of 1.7 respectively. The study can be correlated to findings by Gupta V et.al and Chakraborty N et.al where the reported wastage were 63.76% (2.75) and 61.8% (2.61) for lyophilized vaccines.

Findings related to oral and injectable vaccine wastage

In the present study, the highest Oral vaccine wastage rate was 56.7% with wastage factor of 2.3 while Pallanivel C et.al and Patle et.al reported lower oral vaccine wastage of 48.1% (1.9) and 33.18% (1.50)^(6,7,9,12,15). The present study found that for Injectable vaccine wastage, the highest wastage rate was 57.99% with wastage factor of 2.3 while Chakraborty N et.al showed a lower wastage of 54.7% (2.20)^(7,9,15).

Findings related to doses per vial wastage

For 5 dose vials, the highest wastage rate was 54.6% with wastage factor of 2.2 while Daya P et.al reported lower wastage of 46.5% (1.86) compared to the present study (12,15,16).

For 10 dose vials, the highest wastage rate was 52.7% with wastage factor of 2.1 which was lower compared to Chakraborty N et.al reported wastage of 55.8% (2.26) but higher than Pallanivel C et.al reported wastage of 51% (2)^(6,7,9,15).

For 20 dose vials, the reported highest wastage was 63.4% (2.7) which was higher than the reported wastage of 48.1% (1.9) by Pallanivel C et.al. The reported lowest wastage was 2.9% (1.0) while Parmar D et.al and Bagdey P et.al reported higher wastage of 6.70% (1.07) and 4.26% (1.04)^(9,13,14).

As for 25 dose vials, the reported highest wastage was 86.6% (7.4) and the reported lowest wastage was 0.9% (1.0) respectively.

From the findings of the present study and the results of similar studies, it can be concluded that the wastage rate and wastage factor were not the same for different vaccines in different settings. Lyophilized vaccines showed a higher frequency of wastage as compared to liquid vaccines mainly because of the time period of viability and there were a number of causes for vaccine wastage such as less number of beneficiaries and insufficient doses in vial.

Limitations: The study findings cannot be broadly generalized as the study sample was not large and was conducted only in selected Urban Health Care Centres of East Khasi Hills, Meghalaya.

Conclusion

Monitoring vaccine wastage helps to improve vaccine forecasting and minimize wastage and a number of

factors influence the vaccine wastage including type of vaccines, syringes, immunization practices and policies. The study reveals wastage rates of different vaccines with various causes of vaccine wastage reported by participants such as loss of doses during administration, expiry of vaccines, VVM reaching discard point. Thus, it can be concluded that proper monitoring of vaccine wastage is essential to minimize vaccine wastage.

Ethical clearance: Taken from the ethical committee of the institute.

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