Original Research

A STUDY ON COLD CHAIN MAINTENANCE AND VACCINE MANAGEMENT PRACTICES OF URBAN GOVERNMENT HEALTH FACILITIES IN JABALPUR DISTRICT, INDIA

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ABSTRACT

Introduction: Efficient cold chain and vaccine logistics management are made possible by the health system's processes, practices, and policies, which are evaluated by Effective Vaccine Management, a diagnostic tool. A significant number of urban Jabalpur children receive vaccinations from a government health facility. The aim of the study was to Assess the cold chain maintenance and vaccine management practices at urban government Cold Chain Points of Jabalpur district. **Methods:** A cross-sectional study was carried out at all of 13 urban government Cold Chain Points across Jabalpur district. Globally validated World Health Organization - United Nations International Children's Emergency Fund Effective Vaccine Management tool was used for this study. Criteria wise and Consolidated Effective Vaccine Management scores were calculated as per World Health Organization guidelines. **Results**: All the urban service point stores or cold chain points scored more than the target 80% in two criteria: storage capacity and building. The consolidated criteria score of all the cold chain points in urban Jabalpur, criteria like maintenance, stock management, management information system, and supportive functions, were lagging behind the 80% mark. Low scores in maintenance, stock management, and management information system and supportive functions criteria are somehow a setback for all the preparation and hard work done towards optimal vaccine management and supply chain in the area. **Conclusion**: The overall performance of the urban cold chain points in Jabalpur district was far better as compared to the state-level effective vaccine management assessment done in Madhya Pradesh in 2011 and 2016. Planned preventive maintenance for buildings and equipment needs to be strengthened. Issues like Lack of information for stock management, need for periodic refresher trainings are to be emphasized.

Keywords: Cold Chain, Vaccines, Management, Storage, World Health Organization, Criteria

Introduction:

Since vaccines are intricate biological products, exposure to temperatures above or below the advised range of 2 to 8°C may cause them to lose some of their effectiveness or even cause damage (World Health Organization, 2005). The potency of vaccines is extremely sensitive to the cold chain status (Woldemichael et al., 2018), which can be lost and cannot be recovered from exposure to extreme heat, cold, or light (Vaccine Storage and Handling Toolkit, 2021). The World Health Organization estimates that up to 50% of vaccines are wasted globally every year; a large part because of lack of temperature control and the logistics to support an unbroken cold-chain (United Nations Environment Programme, 2020).

The potency of vaccines is extremely sensitive to the cold chain status, which can be lost and cannot be recovered from exposure to extreme heat, cold, or light. This grave error can lead to numerous detrimental consequences, affecting the effectiveness and safety of the vaccines, reduced Vaccine Potency, Improper storage and transportation may result in the spoilage of vaccines, leading to substantial wastage, Improper cold chain management may compromise the efficacy of vaccines, leaving individuals defenceless or under-protected. This can contribute to an increased risk of disease transmission, if a large number of vaccines lose their efficacy due to poor cold chain management, there is an increased risk of outbreaks and resurgence of vaccine-preventable diseases. This is particularly concerning in regions where these diseases have been controlled or eradicated (World Health Organization, 2005).

Most of the vaccine are to be kept at a narrow temperature range between two and eight degrees centigrade in order to remain effective. In routine immunization Programme in India many vaccines are classified as heat sensitive vaccines and cold sensitive vaccines. So, it's very necessary to store these vaccines in range bound temperature (2 to 8 degree Celsius) in proper cold chain storage facilities.

India has made significant strides in vaccination coverage by improving cold chain and logistics management, strengthening reporting of vaccine-preventable infections, and becoming self-sufficient in vaccine production. With a focused approach at the district level, recent projects like Mission Indradhanush (MI) in 2014 and its intensified variants, MI 2.0 and MI 4.0 in 2017 and 2022, respectively, have advanced these efforts (Johri et al., 2021) (Gurnani et al., 2018) (Rajpal et al., 2023). According to National Family Health Survey -5 (2019-20) reports ONLY 76.4% Children age 12-23 months fully vaccinated based on information from either vaccination card or mother's recall (%) (National Family Health Survey- 5, 2020). The vaccination supply chain system is one of the important components that need more attention for the immunization program to be implemented effectively. Immunization supply chain system comprises the people, data, assets, and processes that manage the data collection, forecasting, ordering, distribution, storage, and delivery of vaccines.

WHO-UNICEF have developed the Global Effective Vaccine Management (EVM) initiative, it is a widely recognized instrument used by national and state program managers for the procedural assessment of the cold chain and vaccine management system in order to identify and address shortcomings using quantifiable indicators under various criteria, categories, and priorities at all supply chain levels (Effective Vaccine Management (EVM), 2019). EVM also contributes to more equitable resource

allocation. It paints a picture of an all-inclusive supply chain for vaccines, from the federal level to remote medical facilities that store vaccines.

The study is conducted to assess the current performance of the immunization supply chain at urban CCPs using the EVM assessment tool in order to identify key strengths, weaknesses, and bottlenecks and to use these results to interpret into an inclusive plan of action, identifying interventions and activities to address both present and potential obstacles. In order to do so, the Present study was done with the objective of Assessment of the cold chain maintenance and vaccine management practices at urban government Cold Chain Points of Jabalpur district.

Methods

Study Design and Study Area

It was a cross-sectional descriptive study conducted in Jabalpur district of Madhya Pradesh during AUG 2022- DEC 2022.All the urban government cold chain points were included in the study.

Study Tools and Technique

The WHO-UNICEF EVM tool version 1.0.9 was used for the assessment (*EVM Assessment Tool User Guide Version 1.0.9*, 2013). The basics of the EVM tools were learned through online EVM training course under guidance of nodal officer of NCCVMRC (National Cold Chain and Vaccine Management Resource Centre).

The tool has a comprehensive structured questionnaire for the assessment of Immunization supply chain. Questions pertaining to Cold Chain Equipment's status and their management from the WHO-UNICEF EVM tool were used for the present study. WHO-UNICEF EVM guidelines, recommends a minimum 80% score in criteria and category for a healthy immunization supply chain. The assessment of the effective vaccine management is done using seven categories and nine criteria. Each category receives the appropriate amount of weight based on how important it is to the program. The WHO recommends a minimum performance of 80% for each criterion. Table 1 depicts the relation between each criteria and categories with weightage as per the global EVM assessment tool (Effective Vaccine Management (EVM), 2019).

Table 1: Relationship between the 9 criteria and 7 categories of EVM Assessment Tool.

EVM Criteria Indicator	EVM Categories						
	Building	Capacity	Equipment	Management	Repair and Maintenance	Training	Vehicle
Vaccine Arrival				93%		3%	3%
Temperature				34%		66%	
Storage Capacity		90%		10%			

Building, Equipment & Transport	45%		40%			15%
Maintenance				100%		
Stock Management		1%	99%			
Distribution			63%		37%	
Vaccine Management practices in the field			41%		59%	
Management Information System and Supportive Function			100%			

All the cold chain points were visited for data collection on days of immunization of the week i.e., Tuesdays and Fridays, to observe all the practices during immunization sessions at each cold chain point. Collection of data for EVM assessment was observational, record and interview based. The records were reviewed and all observations were noted on immunization days.

Inclusion and exclusion Criteria - All the Urban Government Cold Chain Points (CCPs) in the Jabalpur District were included in the study. Cold chain points were considered to be excluded if there was no cold chain handler available on visiting the facility two times. But fortunately, all the cold chain handlers were present at the time of visit.

Study Sample – All the 13 urban Cold Chain Points of service point stores are included in the study.

Table 2: Names of Cold Chain Points of Jabalpur District.

S.no	Service Points Stores /Cold Chain Points
1	#PHC Bargi
2	PHC Barela
3	Netaji Subhash Chandra Bose Medical College Cold chain point
4	#UPHC Gohalpur
5	UPHC Cantt
6	UPHC Gupteshwar
7	UPHC Polipathar
8	UPHC Ranjhi
9	UPHC Rani Durgawati
10	Victoria Hospital Cold chain point
11	UPHC Sanjay Nagar
12	UPHC Tilwara
13	UPHC Manmohan Nagar

PHC- Primary Health Centre, UPHC – Urban Primary Health Centre

Ethical Consideration - The ethical approval with order no- IEC/2020/120 obtained from Institutional Ethics Committee of Netaji Subhash Chandra Bose Medical College. Further permission from the DISTRICT administrative head, Chief Medical and Health Officer (CMHO) of the Jabalpur health department were also taken.

Data analysis- Data collection from all the cold chain points was done by using standard EVM assessment tool. Data collection was done by a single observer to avoid any inter observer bias. Data were compiled using MICROSOFT EXCEL 2013 and descriptive statistical test was applied using Statistical Package for the Social Sciences statistical software version 22. Criteria and category wise performance of all the urban CCPs was calculated and performance was evaluated. Aggregate criteria and category score of the urban area of Jabalpur district was calculated and spider charts was prepared.

Result

In the Present study, all the thirteen-service point (SP) stores or CCPs of urban Jabalpur were included, out of all the 9 Criteria, Vaccine Arrival criteria and Vehicle Category is not applicable at the SP level stores. All the urban Service point Stores or CCPs scored more than target of 80 % in two criteria i.e. 100 % in Storage Capacity and also 100 % in Equipment Transport & Building as shown in Table 3. while in Temperature, Distribution, Vaccine Management Criteria all the CCP had more than 80 % score expect the one CCP (UPHC Gohalpur).

Table 3: Distribution of all urban Cold Chain Points as per Criteria-wise EVM Scores at Service Point Stores (N=13)

SN	CRITERIA SCORES	< 80%	≥ 80%
1	VACCINE ARRIVAL	N/A[*]	N/A[*]
2	TEMPERATURE	1 (7.7%)	12 (92.3%)
3	STORAGE CAPACITY	0	13 (100%)
4	BUILDING, EQUIPMENT & TRASPORT	0	13 (100%)
5	MAINTENANCE	12 (92.3%)	1 (7.7%)
6	STOCK MANAGEMENT	7 (53.8%)	6 (46.2%)
7	DISTRIBUTION	1 (7.7%)	12 (92.3%)
8	VACCINE MANAGEMENT	1 (7.7%)	12 (92.3%)
9	MIS, SUPPORTIVE FUNCTIONS	7 (53.8%)	6 (46.2%)

*N/A – NOT APPLICABLE FOR CURRENT SERVICE POINT DELIVERY STORES.

Considering at the Figure 1. The Consolidated Criteria score of all the CCP of urban Jabalpur, Criteria Like Maintenance, Stock Management, Management Information System (MIS) & Supportive Functions were lagging behind the 80 % mark.
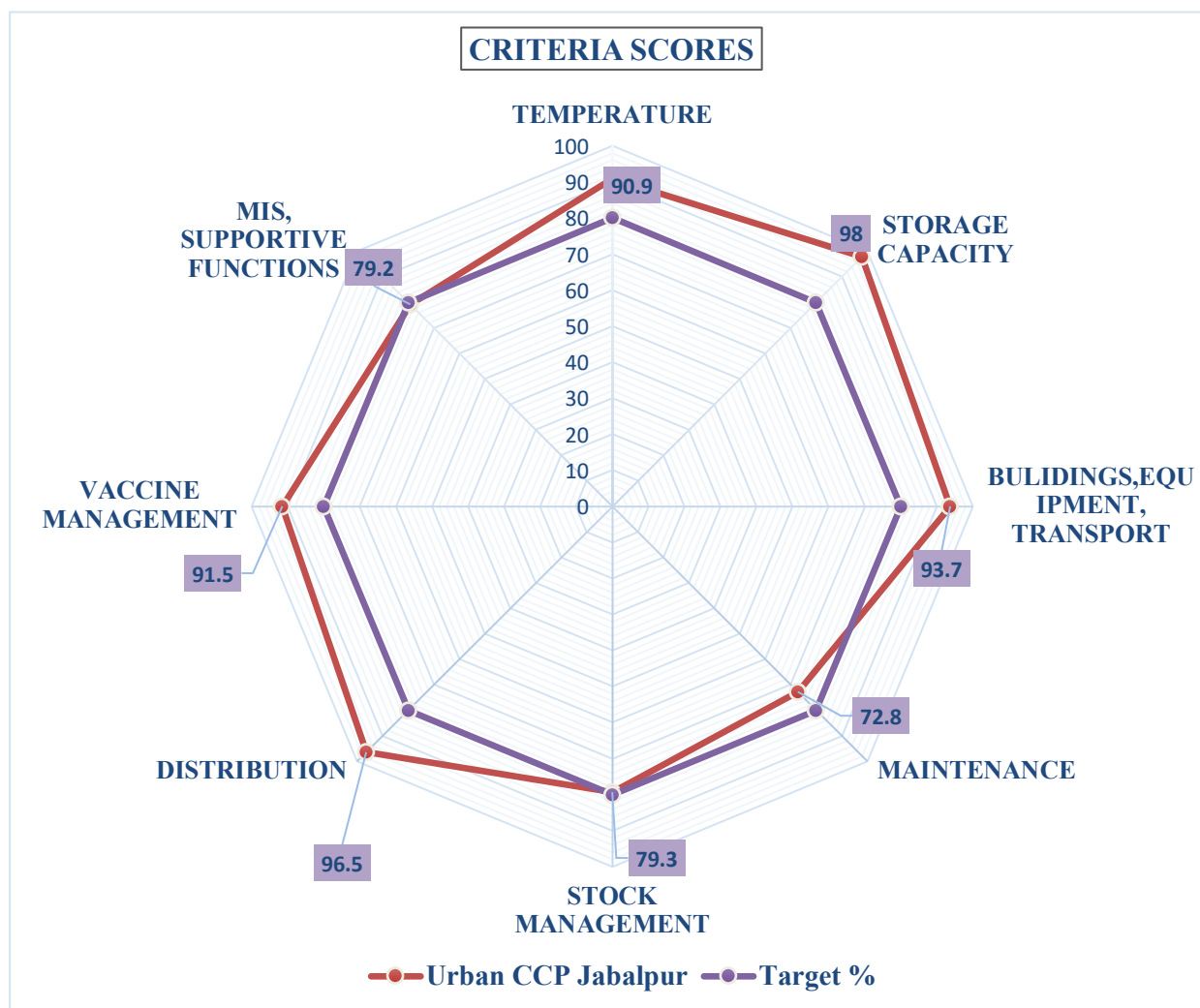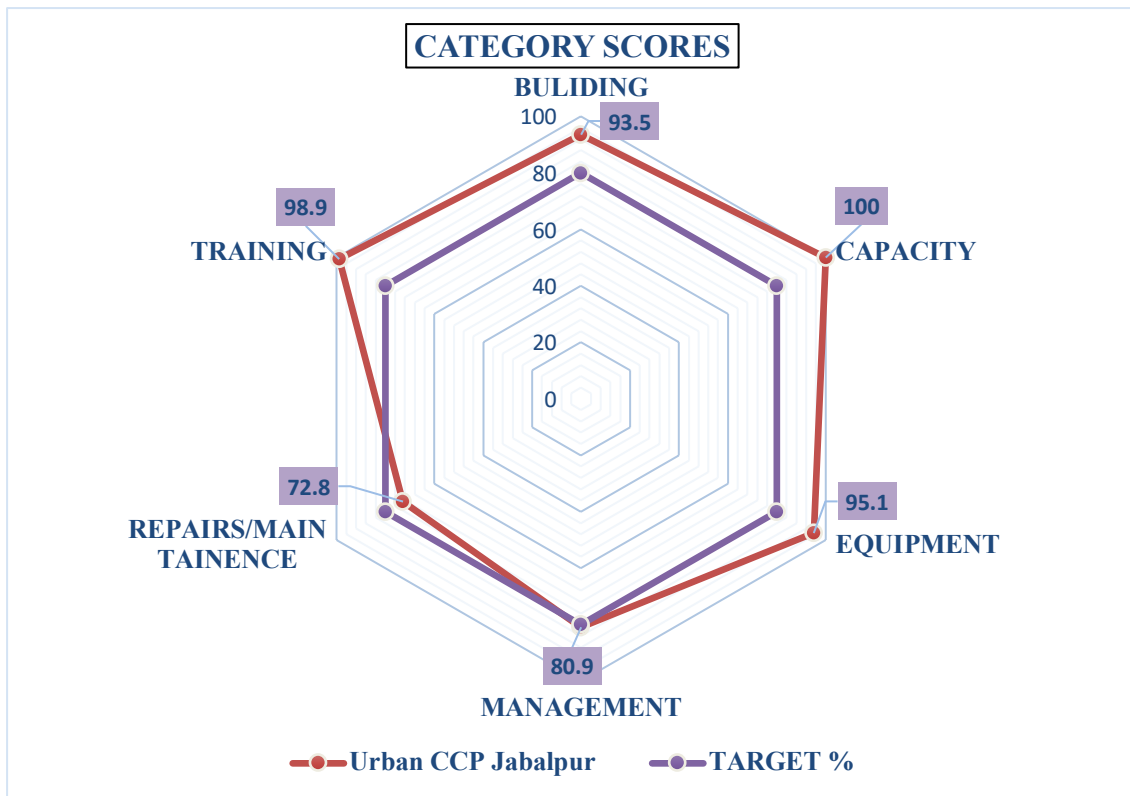

Figure 1: Spider Chart district average of Criteria Scores of urban CCPs Jabalpur district

Observing the Category Score in Table no. 4. Training and Capacity category score of all the CCP had more than 80 % score While Repair and Maintenance was the prominent issue in 12 CCP out of 13. As Shown in Figure 2 the Consolidated Category Score of all urban CCPs of Jabalpur, Repair maintenance was lagging behind the 80 % mark. While Management Category Score was at the Borderline of 80 % mark. The CCPs had excellent Category score of more than 90 % mark in four categories i.e. Capacity, Building, Equipment and Training.

Table 4: Distribution of all the urban cold chain points of Jabalpur district as per the category scores with respect to the target 80% score. (N=13)

SN	CATEGORY SCORES	<80%	≥ 80%
1	BUILDING	2(15.4%)	11(84.6%)
2	CAPACITY	0	13(100%)
3	EQUIPMENT	2(15.4%)	11(84.6%)
4	MANAGEMENT	3(23.07%)	10(76.9%)
5	REPAIRS AND MAINTENANCE	12(92.3%)	1(7.69%)
6	TRAINING	0	13(100%)
7	VEHICLE	N/A[*]	N/A[*]

*N/A – NOT APPLICABLE FOR CURRENT SERVICE POINT DELIVERY STORES.

Figure 2: Spider Chart district average of Category Scores of urban CCPs Jabalpur district.

The consolidated Criteria and Category Scores of Urban CCPs of Jabalpur Were Compared with 2016 Madhya Pradesh EVM score and 2018 National EVM Score India in Table.5. and 6, it was observed that out of nine Criteria Score we have remarkably improved in 5 criteria while out of 7 Category, 5 Category had major improvement in the last 4-6 years.

Table 5: Criteria Scores of Present study in Comparison to 2018 EVM Assessment Report of India.

S. No	CRITERIA SCORES	Jabalpur Urban CCP 2022 (present Study) EVM score	Madhya Pradesh 2016 EVM score	2018 National EVM Score
1	VACCINE ARRIVAL	NA	NA	NA
2	TEMPERATURE	**90.9 %**	69 %	78 %
3	STORAGE CAPACITY	**98 %**	**89 %**	**94 %**
4	BUILDING, EQUIPMENT & TRANSPORT	**93.7 %**	**80 %**	**81 %**
5	MAINTENANCE	72.8 %	61 %	65 %
6	STOCK MANAGEMENT	79.3 %	59 %	60 %
7	DISTRIBUTION	**96.5 %**	69 %	52 %
8	VACCINE MANAGEMENT	**91.5 %**	**77 %**	**83 %**
9	MIS, SUPPORTIVE FUNCTIONS	79.2 %	49 %	52 %

Table 6: Category Scores of Present study in Comparison to 2018 EVM Assessment Report of India.

S. No	CATEGORY SCORES	Jabalpur Urban CCP 2022 (present Study) EVM score	Madhya Pradesh 2016 EVM score	2018 National EVM Score
1	BUILDING	93.5 %	76 %	80 %
2	CAPACITY	100 %	95 %	98 %
3	EQUIPMENT	95.1 %	81 %	80 %
4	MANAGEMENT	80.9 %	56 %	60 %
5	REPAIRS AND MAINTENANCE	72.8 %	61 %	65 %
6	TRAINING	98.9 %	84 %	90 %
7	VEHICLE	NA	NA	NA

Discussion

In the present study most of the cold chain points scored more than target 80% in all the criteria except Stock Management & MIS, Supportive Functions criteria. while in the study done in Meerut, India in 2018 the stores performed the poorest in three criteria (Buildings, Equipment and Transport, Maintenance and MIS, Supportive Functions). only 1 store has more than 80 % out of total 14 stores. The study contemplates for upgrading the Cold Chain Points at urban Meerut in terms of building, infrastructure and maintenance as it was in a very poor state. (Kumar Bhatnagar et al., 2018)

According to the national EVM assessment score 2013 the Service Point Stores (N=52) Scored the least in Stock Management (45%) and Maintenance (47%) criteria while it has scored highest in the Distribution (77%) criteria (National Effective Vaccine Management Assessment India 2013, 2014). National EVM assessment 2018 scored the least in two criteria - Distribution and MIS& Supportive Function i.e. 52% out of 62 Service Point Stores while it has scored the highest in Storage Capacity (94%) (NCCVMRC-NIHFW & UNICEF, 2019). EVM Assessment in Maharashtra done in 2011 on 25 PHCs and 12 UHPs (37 SPS) Scored less than the target 80% mark in all the criteria and the least in MIS & Supportive Functions i.e. 9% while Maintenance of Building, Cold Chain & Transport (41%) and Stock Management (42%) respectively **(**Assessment of Effective Vaccine Management in Maharashtra, 2011). The Service Point Stores performed better in Storage Capacity (79%) and Building, Cold Chain Equipment & Transport (73%) criteria. In all the above assessments the most common criteria which was lagging behind was MIS & Supportive Functions. The reason behind it may be due to the struggle of Cold chain handlers to cope up with the recent advances in the technology or software used to update vaccines & consumables in the facility and to perform supportive supervision in the field.

According to the National EVM assessment score 2013 the Service Point Stores (N=52) Scored the least in Repairs / Maintenance (49%) and Management (51%) categories, and scored more than target 80% in only one category that is Capacity (88%) (National Effective Vaccine Management Assessment India-2013, 2014). National EVM assessment score 2018 scored the least in two capacity Management (60%) and Repairs / maintenance (65%) out of Service Point Stores (N=62).and scored the highest in Capacity (98%) Category (NCCVMRC-NIHFW & UNICEF, 2019). EVM Assessment in Maharashtra done in 2011 on 25 PHCs and 12 UHPs (37 SPS) scored less than the target 80% in all the categories except one Capacity (90%) category and the least in Repair & Maintenance i.e. 41% and Management (46%) categories respectively (Assessment of Effective Vaccine Management in Maharashtra, 2011).

As per the Gujarat's EVM 2019 (UNICEF Gujarat & NCCMIS, 2020) report Assessment done in 82 Service points/ CCPs founds that two criteria Indicators namely maintenance & repair and MIS & Supportive functions are lagging behind the 80 % marks. While other criteria indicators were in better position in comparison to neighbouring state of Madhya Pradesh.

Madhya Pradesh EVM Assessment 2016 was done in 40 service point stores across the state including few SP stores/CCP of Jabalpur District. The Report stated only the two criteria out of nine and three categories out of 7 were crossed the 80 % expectable marks (Shah, 2016). From that period the states have gone a tremendous Transformation in terms of Logistics, supply and Managements that the present study has reported a remarkable improvement in 5 criteria and 5 Categories. As per the present study observation Three criteria which still needs a major transformation or a look up even after the 4-6 years is Maintenance, Stock management and MIS Supportive Functions. Low score in These Criteria are somehow a setback for all the preparation and hard work done towards optimal Vaccine management and supply chain in the area. The Above three criteria Contains major components of two Categories of EVM -Management and Repair Maintenance as shown in the Fig.1. The Components of Criteria and Categories are interlinked. Based on the scores of Criteria indicator action can be taken under the respective categories for improving the performance of the different programmatic areas associated with the supply chain.

The problem in the maintenance part was that the plan for the maintenance of buildings was not available for most of the CCPs at the SP level. Similarly, planned preventive maintenance for equipment is not available at many sites, while in a few others it is not standardized. Few buildings require attention for renovation. To overcome this problem, stakeholders at the state level have to execute a uniform standard of guidelines that should be implemented strictly at all service points, or CCPs.

Other challenge that we have observed in the present study was the improper stock management. The first necessary thing for stock management is to have proper vaccine distribution plans at SP level, that was not available across many vaccine stores. Instances of vaccine stock out were fairly common in few CCPs. Vaccine wastage records are not maintained across all CCPs. Vaccine wastage review mechanism is not established in the district. Knowledge of shake test amongst Cold Chain Handlers was poor at SP level stores. To deal with this challenge, the Vaccine forecasting mechanism to be streamlined at all CCPs. Maximum minimum and reorder stock levels for all Vaccines to be set at all stores. Monthly cold chain review for vaccine wastage, Temperature records & excursion and other cold chain parameters to be conducted by medical officer in charge in supervision of District Immunization officer.

The Third challenge was the Management Information System, Supportive Functions- Though the state has adopted the Evidence based vaccine and syringe forecasting Software but the Cold chain handlers are not updating it regularly. Supportive supervision was not done regularly as all the CCPs are of urban areas, the districts officials consider the peripheral CCPs as their priorities and little or no supportive supervision is provided in the urban areas. To overcome this Lacunas, the District Immunization officer supposed to ensure development of a quarterly supervision plan for district level supervisors and monitor, its implementation during Routine immunization reviews/ District Task Force on Immunization meetings. Supervision plan to include coverage of all service point stores in the district at least two to

three times on yearly basis with accompanying community and session sites. At state level, Preventive Maintenance protocols to be standardized and implemented in every District.

The present study has included all the Urban Cold Chain Points of Jabalpur District. It is the first assessment at the state level which has shown the comprehensive picture of the cold chain points in the district. Earlier in the state or national EVM assessment only two or three CCPs of district were randomly included. Also in the present study, there may be remarkable improvement in few scores in urban areas but it may be possible that if peripheral/rural Cold chain points were included it might had given different impression.

Conclusion

The overall performance of Urban CCPs of Jabalpur district was far better as compared to the state level EVM assessment done in MP on 2011 & 2016. An improvement in all the criteria and category scores was found in the present study. Repairs and Maintenance was the criteria in which all the Service Point (SP) stores needs improvement. Proper administration and supportive supervision and monitoring activities may guarantee an improvement in performances in a few years. Planned preventive maintenance for buildings and equipment's needs to be strengthen. Issues like Lack of information for stock management, need for periodic refresher trainings and increase workload of Cold Chain Handlers (CCHs) are a few factors responsible for gaps in EVM assessment.

Conflicts of Interest

The authors declare no conflicts of interest.

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