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Evaluation of Cold Chain and Vaccine Management Practices at Cold Chain Points in Durg, Chhattisgarh

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Abstract

Background: Effective vaccination relies on cold chain integrity, but infrastructure and training challenges in regions like Durg, Chhattisgarh, India, can compromise vaccine efficacy. This study assesses cold chain practices and gaps in Durg's healthcare facilities.

Method: A cross-sectional study across 15 health facilities utilized a structured checklist, examining cold chain equipment, temperature monitoring, and vaccine management.

Results: Most facilities maintained functional cold chain equipment and diligent temperature monitoring. However, gaps were found in equipment placement (57.1% compliance) and instances of vaccine damage (35.7%).

Conclusion: Addressing equipment placement, enhancing staff training, and improving monitoring documentation are key to bolstering vaccine safety and program effectiveness.

Keywords: Vaccination, Cold Chain, Public Health, Immunization, Durg

. *Introduction*

Vaccination is one of the most effective public health interventions to prevent infectious diseases and improve population health[1]. However, the success of vaccination programs is significantly dependent on the maintenance of the **cold chain**, which encompasses the systematic storage, handling, and transportation of vaccines at recommended temperatures[2]. A successful vaccination program relies on an effective cold chain system, ensuring vaccines are stored and transported at regulated temperatures to maintain potency[3]. Any disruption in this system can lead to vaccines losing efficacy, resulting in severe consequences, particularly among vulnerable populations like infants[4].

The state of **Chhattisgarh** has seen multiple tragic incidents related to vaccine mismanagement. Recently, the state reported its **fourth infant death** allegedly due to failures in the cold chain[5]. In light of these incidences and exploration into earlier research highlights that improper storage and transport conditions can result in vaccines being exposed to temperatures outside the recommended range, leading to potency loss and potential adverse outcomes upon administration[6].

Durg, a district in Chhattisgarh, India, faces unique challenges in healthcare delivery, necessitating a comprehensive assessment of cold chain and vaccine management practices[3]. This study seeks to elucidate the current state of cold chain maintenance, identify existing gaps, and propose actionable recommendations to enhance vaccine management practices.

2. Methods

2.1 Study Design and Setting

A cross-sectional study design was utilized, conducted across various cold chain points in **Durg July 2024**. The selected sites included government health facilities at different levels, including primary health centers (PHCs), community health

centers (CHCs), and district hospitals.

2.2 Sample Size and Sampling Technique

Durg district in Chhattisgarh covers an area of 2,238 sq. km with a population of approximately 1,721,726[7]. The district is administratively divided into 3 blocks: Durg (Nikum), Patan and Dhamdha. The healthcare infrastructure in the district includes 1 district hospital, 8 Community Health Centers, 36 Primary Health Centers, and numerous Sub-Health Centers. There are 40 functional Cold Chain Points (CCPs) and 1 district vaccine store to ensure the proper storage and distribution of vaccines throughout the district[8]. Out of which 15 health facilities were included in the study due to time constraint and logistic feasibility

The data collection process involved physical assessments of CCPs, including direct observations and interviews with key personnel. This approach ensured a thorough and accurate collection of both quantitative and qualitative data regarding cold chain management and routine immunization practices.

2.3 Data Collection Tools

A pre-tested predesigned structured block level checklist named "supportive supervision of cold chain and vaccine management" prescribed by Government of India was used to collect the data[9]. Out of 98 questions in the checklist those questions which were of relevance to study objectives were included in the study. Data was collected on the six components: background information of the cold chain point, information on human resource, cold chain equipment and its maintenance, temperature monitoring, vaccine management, and monitoring and supervision information[10].

2.4 Data Analysis

The data was entered and cleaned in MS Excel, then analyzed using SPSS version 26. Results were presented in terms of frequencies and percentages.

**In a random selection of 15 health facilities, 14 were found to have operational Cold Chain Points (CCPs), while one facility did not have a CCP*

3. Results

3.1 Background Information

CCPs show robust capacity in logistical planning and storage, with 100% having adequate dry storage space. Nearly all CCPs (92.9%) maintain up-to-date RI microplans and provide precise estimates for vaccines and supplies, ensuring readiness for immunization sessions.

Table 1. Background Information of the Cold Chain Point		*Count*	*Column N %*
Does the CCP have adequate space for dry storage?	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Does the RI microplan have complete vaccine & logistics estimates	*Yes*	*13*	*92.9%*
	No	*1*	*7.1%*
Is there an updated microplan available in the CCP for the current financial year	*Yes*	*13*	*92.9%*
	No	*1*	*7.1%*

3.2 Human Resource:

The majority (92.9%) of CCPs have a dedicated Medical Officer (MO) trained on the latest Routine Immunization module, bolstering immunization knowledge. Vaccination Cold Chain Handlers (VCCHs) are similarly trained in most locations, with each CCP generally staffed by one VCCH, though one CCP has two.

Table 2. Information on Human Resource	*Count*	*Column N %*

Is a Medical Officer currently posted for the cold chain point?	*Yes*	*13*	*92.9%*
	No	*1*	*7.1%*
Is the Medical Officer trained on the latest Routine Immunization module for medical officer?	*Yes*	*13*	*92.9%*
	No	*1*	*7.1%*
No. of VCCH present in the cold chain point	*1*	*13*	*92.9%*
	2	*1*	*7.1%*
Are the VCCHs trained on the latest VCCH module?	*One*	*13*	*92.9%*
	Both	*1*	*7.1%*

3.3 Cold Chain Equipment (CCE)

Equipment availability and functionality are high, with all CCPs maintaining operational Ice-Lined Refrigerators (ILRs), Deep Freezers (DFs), Cold Boxes, Vaccine Carriers, and Voltage Stabilizers. This is critical for vaccine preservation across facilities. No equipment is on standby, underscoring optimal utilization.

Table 3. Cold Chain Equipment		*Count*	*Column N %*
ILR	*Not Working*	*0*	*0.0%*
	Working	*14*	*100.0%*
	Standby	*0*	*0.0%*
DF	*Not Working*	*0*	*0.0%*
	Working	*14*	*100.0%*
	Standby	*0*	*0.0%*
Cold Box	*Not Working*	*0*	*0.0%*
	Working	*14*	*100.0%*
	Standby	*0*	*0.0%*
Vaccine Carrier	*Not Working*	*0*	*0.0%*
	Working	*14*	*100.0%*
	Standby	*0*	*0.0%*
Voltage Stabilizer	*Not Working*	*0*	*0.0%*
	Working	*14*	*100.0%*
	Standby	*0*	*0.0%*

3.4 Equipment Maintenance

While most CCPs (57.1%) reported no equipment breakdowns in the past year, 42.9% experienced some issues. Nevertheless, all facilities have Annual Maintenance Contracts (AMCs) or Comprehensive Maintenance Contracts (CMCs) for repairs, and VCCHs are knowledgeable about repair contacts. Recent PPM visits were reported in 92.9% of cases, and 92.9% of VCCHs perform routine daily and weekly checks. However, only 57.1% of CCPs correctly place ILRs/DFs as per guidelines, with some improvement needed in storing cold boxes and vaccine carriers.

Table 4. Equipment Maintenance		*Count*	*Column N %*
Was there any breakdown of CCE reported from the CCP in the last 1 year?	*Yes*	*6*	*42.9%*
	No	*8*	*57.1%*
Is there an AMC/CMC for repair and maintenance of cold chain equipment?	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*

If yes, does the VCCH knows whom to contact for CCE under AMC/CMC	Yes	14	100.0%
	No	0	0.0%
Did the CCT or AMC/CMC service provider visit for PPM in the last 4 months?	Yes	13	92.9%
	No	1	7.1%
Does the VCCH carry out the daily and weekly PPM as per the checklist?	Yes	13	92.9%
	No	1	7.1%
All the ILR / DF are placed as per specified guidelines	Yes	8	57.1%
	No	6	42.9%
Are the Cold boxes stored properly in the store?	Yes	13	92.9%
	No	1	7.1%
Are the vaccine carriers stored properly in the store?	Yes	9	64.3%
	No	5	35.7%
Are the ice packs correctly placed for freezing in the DF?	Yes	11	78.6%
	No	3	21.4%
Are contingency plans for vaccine storage displayed appropriately?	Yes	10	71.4%
	No	4	28.6%
Are the latest standard job aids displayed in the centre?	Yes	6	42.9%
	No	8	57.1%

3.5 Temperature Monitoring

Temperature control practices are exemplary, with all CCPs equipped with dedicated, functioning thermometers and logbooks for recording. Records are diligently updated twice daily, with monthly reviews, ensuring vaccines are stored at optimal temperatures. VCCHs can demonstrate thermometer use and temperature reading accuracy.

Table 5. Temperature Monitoring		*Count*	*Column N %*
Are there dedicated functional thermometers for each functional CCE?	Yes	14	100.0%
	No	0	0.0%
Are there dedicated standard temperature log books for each installed CCE?	Yes	14	100.0%
	No	0	0.0%
Are the twice daily recordings (Holidays*) complete and up to date for the last 3 months?	Yes	14	100.0%
	No	0	0.0%
Is there documentation of monthly review of temperature records?	Yes	14	100.0%
	No	0	0.0%
Can the VCCH correctly demonstrate temperature reading from the thermometer?	Yes	14	100.0%
	No	0	0.0%

3.6 Vaccine Management

CCPs are consistent in vaccine stock management, with standard stock registers available and fully maintained. Physical stock verification occurs quarterly, and vaccine storage protocols (e.g., ILR baskets) are followed in all CCPs. Although some facilities reported vaccine damage (35.7%), records are complete. All expired or damaged vaccines are separated from usable stock, and vaccine vial monitoring is thorough, preventing the use of compromised vaccines.

Table 6. Vaccine Management	*Count*	*Column N %*

Does the CCP have standard vaccine and logistics stock / issue registers?	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Are the registers completely filled and up to date?	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Are there any records of damaged vaccines and diluents in the stock register in the last 3 months?	*No Damage occurred*	*9*	*64.3%*
	Damage occurred and recorded	*5*	*35.7%*
	Damage occurred, but not recorded	*0*	*0.0%*
Is there documented evidence of physical stock verification in the last 3 months?	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Does the CCP have documented minimum & maximum stock levels for all antigens?	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Are the vaccines correctly stored in the ILR?	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Are the vaccines kept in the basket in the ILR	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Are the diluents kept in the cold chain at least 24 hours before issuing to the session sites	*Yes*	*11*	*78.6%*
	No	*3*	*21.4%*
Does the CCE contain only UIP vaccines and diluents?	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Is there any vaccine vial beyond usable VVM in the ILR?	*Yes*	*0*	*0.0%*
	No	*14*	*100.0%*
Is there any frozen vaccine in the ILR?	*Yes*	*0*	*0.0%*
	No	*14*	*100.0%*
Is there any vaccine vial beyond expiry date in the ILR?	*Yes*	*0*	*0.0%*
	No	*14*	*100.0%*
Is there any vaccine vial stored in the ILR with unreadable label?	*Yes*	*0*	*0.0%*
	No	*14*	*100.0%*
Is there any open vaccine vial stored in the ILR without date and time mentioned on it?	*No open vial found*	*11*	*78.6%*
	Opened vial found with Date & time	*1*	*7.1%*
	Opened vial found without date & time	*2*	*14.3%*
Have the opened vaccine vials (to be discarded) of the last session day, been kept in cold chain with clear labelling of "Not to be used"?	*Kept as per guidelines*	*0*	*0.0%*
	Guidelines not followed	*0*	*0.0%*
	Such type of vaccine vials not available	*14*	*100.0%*

Can the VCCH correctly demonstrate ice pack conditioning?	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Is there adequate space available for conditioning of ice packs?	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Is there any vaccine kept in the deep freezer?	*Yes*	*0*	*0.0%*
	No	*14*	*100.0%*
Does the CCP have a documented AVD plan for all the session sites	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Does the open vials with reports return from the same day from all the session sites?	*Yes*	*14*	*100.0%*
	No	*0*	*0.0%*
Who is responsible for Vaccine distribution to session sites?	*ANM*	*7*	*50.0%*
	AVD Agency	*7*	*50.0%*
	Both	*0*	*0.0%*
How the immunization waste is disposed off?	*At the safety pit*	*0*	*0.0%*
	Through outsourcing	*14*	*100.0%*
	At the session sites	*0*	*0.0%*
	Not done properly	*0*	*0.0%*

3.7 Monitoring and Supervision

CCPs are subject to regular district-level monitoring, with documentation available for all visits. Cleanliness, however, varies, with only half of CCPs rated as "satisfactory," 42.9% as "average," and 7.1% as "poor."

Table 7. Monitoring & Supervision Information		*Count*	*Column N %*
Is there any monitoring visit by District level authorities in the last 3 months?	*No visits*	*0*	*0.0%*
	Visit was done and documentation available	*14*	*100.0%*
	Visit was done, but no documentation available at the facility. Is the	*0*	*0.0%*
Is the vaccine store and its premises including the store keepers office clean:	*Poor*	*1*	*7.1%*
	Average	*6*	*42.9%*
	Satisfactory	*7*	*50.0%*

4. Discussion

In this study, several gaps were identified in cold chain management practices that highlight areas for improvement. One prominent gap is the **inconsistent placement** of essential equipment like ice-lined refrigerators (ILRs) and deep freezers (DFs), with only 57.1% of facilities positioning them according to specified guidelines. This misplacement not only risks compromising vaccine efficacy but also underscores the need for enhanced training or oversight to ensure compliance with equipment setup standards. Key contributing factors in regions like **Chhattisgarh** include frequent power outages, inadequate refrigeration infrastructure in remote health centers, and a lack of trained personnel to manage temperature

monitoring and early detection of failures[11]. Despite most facilities having trained Medical Officers and Vaccination Cold Chain Handlers (VCCHs), lapses in training—particularly concerning proper equipment placement and vaccine carrier storage—indicate the importance of **periodic refresher courses** and supplemental training, especially for newer staff members.

The study also found that while district-level monitoring visits are an essential component of quality assurance, some facilities lacked thorough documentation of these visits. This gap in record-keeping suggests either infrequent monitoring or inadequate reporting, both of which can reduce accountability and limit opportunities for timely corrective measures. Furthermore, about 35.7% of CCPs reported incidents of damaged vaccines; although these were documented and separated from usable stock, the frequency of such incidents signals areas for improvement in vaccine handling and storage practices. In some facilities, vaccine carriers and cold boxes were not stored in line with recommended standards, potentially compromising vaccine safety, especially during transport to immunization sites. Another noted challenge was space constraints for conditioning ice packs, an issue observed in facilities that shared space with other health services. This limitation affects the efficiency of vaccine cooling and overall storage management.

5. Recommendations:

1. **Ensure Proper Equipment Placement:**

   Standardize ILR and DF placement through routine audits, checklists, and visual guides to align with specified guidelines.
2. **Enhance Training for Staff:**

   Conduct regular refresher courses for Medical Officers and VCCHs on equipment setup and vaccine storage, and provide onboarding training for new staff.
3. **Improve Monitoring and Documentation:**

   Strengthen record-keeping of district-level monitoring visits to enhance accountability and ensure timely corrective actions.
4. **Optimize Vaccine Handling and Storage:**

   Address frequent vaccine damage by reinforcing safe handling practices and ensuring proper storage of vaccine carriers and cold boxes.
5. **Address Space Constraints for Ice Pack Conditioning:**

   Allocate dedicated space for conditioning ice packs to improve vaccine cooling and storage efficiency.

3. Conclusion

This study highlights the critical role of robust cold chain management practices in maintaining vaccine efficacy within Durg's healthcare facilities. While many facilities demonstrated effective logistical planning and equipment maintenance, several gaps were identified that could compromise vaccine safety, such as inconsistent equipment placement and improper storage practices. The health implications of cold chain failures are severe, as administering compromised vaccines may cause adverse reactions or fail to protect against diseases, ultimately eroding public trust in immunization programs[12]. In states like **Chhattisgarh**, where immunization programs are critical for disease prevention, such incidents can lead to vaccine hesitancy, exacerbating public health challenges. To address these issues, significant measures are needed. Investments in **solar-powered refrigeration units** and reliable backup power systems can help mitigate power-related disruptions. Research supports the integration of **real-time monitoring systems**, including temperature loggers

and GPS trackers, to identify lapses promptly[11]. Further, improving **training programs** for healthcare personnel and creating awareness in local communities about vaccine safety and storage practices are essential. Strengthening infrastructure and logistics, particularly in remote areas, is equally critical to ensuring vaccines reach their destination without loss of quality. By optimizing the existing cold chain infrastructure and refining management practices, Durg can ensure safer vaccine distribution, ultimately contributing to improved public health outcomes in the region.

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