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Original Article

Evaluation of the cold chain in Primary health centres of Surendranagar District

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ABSTRACT

Background: India's immunization program depends on an effective cold chain to maintain vaccine potency and reduce childhood morbidity and mortality. 1 Vaccines are immunobiological substances that provide protective immunity against specific diseases. 2 Improper storage, transport, preparation, or administration can reduce vaccine potency. 3 This study evaluated cold chain equipment, maintenance practices, and vaccinators' knowledge.

Methods: A cross-sectional study was conducted in 20 randomly selected PHCs across all 10 talukas (2 PHCs from each taluka by random sampling) of Surendranagar district from January 2023 to June 2024. All cold chain points and their handlers were included. Data were collected through interviews and direct observation using a validated, pretested, semi-structured questionnaire and were analysed using descriptive statistics.

Result: The majority of Cold Chain Handlers were aged 30–39 years (70%), male (65%), and pharmacists (80%); 35% had not received RI training in the previous three years. Most Cold Chain Points had adequate infrastructure, with 100% internet access and cold chain storage, but only 5% NCCMIS implementation and 35% power backup. Cold chain practices were satisfactory, with 90% maintaining recommended ILR and DF temperatures and 70% maintaining ILR frost below 5 mm. Knowledge was good for light-sensitive vaccines (100%), VVM (80%), and the open vial policy, although only 55% demonstrated good knowledge of the Shake Test.

Conclusion: The cold chain system in Surendranagar district was largely functional and guideline-compliant. However, improvements in power backup, training, digital reporting, and infrastructure are needed to strengthen immunization services.

Keywords: *Cold chain handler, shake test, conditioning.*

INTRODUCTION

Immunization is one of the best-efforts India is currently making to combat various vaccine-preventable diseases. [1] The Universal Immunization Programme (UIP) was introduced in India in 1985, targeting infants and pregnant women. [2] Immunization is a major public health investment in India. [1] The effectiveness of the immunization programme relies on uninterrupted cold chain maintenance throughout vaccine storage and transport. [1] Primary Health Centres (PHCs) are the backbone of routine immunization services in rural India. Therefore, maintaining an effective cold chain at PHCs is essential to ensure vaccine potency, although deficiencies in cold chain maintenance continue to be reported. 3-6 Health workers are key components of the vaccine cold chain system4 Adequate knowledge of health workers, proper maintenance of cold chain equipment (ILR and deep freezer), and adherence to emergency contingency plans are essential for effective immunization services. 1 This study evaluated the cold chain system in selected Primary Health Centres (PHCs) of Surendranagar district by identifying gaps in cold chain infrastructure and maintenance practices. It also assessed the knowledge and practices of Cold Chain Handlers (CCHs) regarding vaccine storage, temperature monitoring, vaccine management, and adherence to standard cold chain guidelines.

METHODOLOGY:

This observational, cross-sectional survey was conducted in Surendranagar district, Gujarat, from January 2023 to June 2024 to assess the status of the vaccine cold chain system. The study included selected Primary Health Centres (PHCs) and their respective Cold Chain Handlers (CCHs). Surendranagar district comprises 10 talukas and 58 government PHCs. A multistage sampling technique was adopted, wherein all 10 talukas were included in the first stage, followed by the selection of two PHCs from each taluka using simple random sampling, resulting in a total of 20 PHCs. All Cold Chain Points (CCPs) and Cold Chain Handlers at the selected PHCs were included in the study.

After the taking a consent form district level and taluka level higher health officer authority, Data were collected through personal interviews and direct observation using a validated, pretested semi-structured questionnaire adapted from the Handbook for Vaccine and Cold Chain Handlers (Government of India, 2016). The assessment covered demographic characteristics of CCHs (age, sex, designation, and educational qualification), availability and functionality of cold chain infrastructure and logistics, storage and maintenance of cold chain equipment, temperature monitoring practices, vaccine management, record maintenance, contingency planning, and human resource characteristics, including availability, training, and work experience. The knowledge and attitudes of Cold Chain Handlers regarding vaccine storage, temperature monitoring, Vaccine Vial Monitor (VVM), Open Vial Policy, Shake Test, and management of heat- and freeze-sensitive vaccines were also assessed. Data were entered into Microsoft Excel and analysed using descriptive statistics, including frequencies, percentages, and graphical representations.

Operational definitions

- Cold chain Point: Cold chain means the system of storing and transporting vaccines at recommended temperatures from the point of manufacture to the point of immunization. 7
- Cold chain handler: The cold chain handler is a key person for maintenance of the cold chain & vaccine management and is responsible for safe storage of vaccines under the Universal Immunization Programme. 7

In-charge cold chain handler: A designated individual responsible for overseeing the entire cold chain process, ensuring proper storage and distribution of temperature-sensitive products like vaccines, by strictly adhering to established standard operating procedures (SOPs) and monitoring temperature levels throughout the chain due to the absence of first cold chain handlers. 7

- Vaccine: is an immunobiological substance that stimulates protective antibody production to defend against specific diseases. 7
- Vaccine vial monitoring: VVMs are labels attached to vaccine vials that contain a heat-sensitive material that changes colours when exposed to excessive heat, signalling when the vaccine should be discarded. 7
- Heat-sensitive vaccines: are those whose effectiveness and safety are compromised when exposed to temperatures above a certain threshold, typically above +8°C, and require strict temperature control during storage and transportation to maintain their potency. 7
- Freeze-Sensitive Vaccine: A freeze-sensitive vaccine can lose its potency or become damaged when exposed to freezing temperatures, necessitating specific storage and handling conditions to maintain its effectiveness. 7
- Cold Chain Equipment (CCEs): refers to the designated, structured, and appropriately maintained area allocated for the installation, operation, and storage of CCEs, such as refrigerators, freezers, ice pack conditioners, and dry storage units. 7

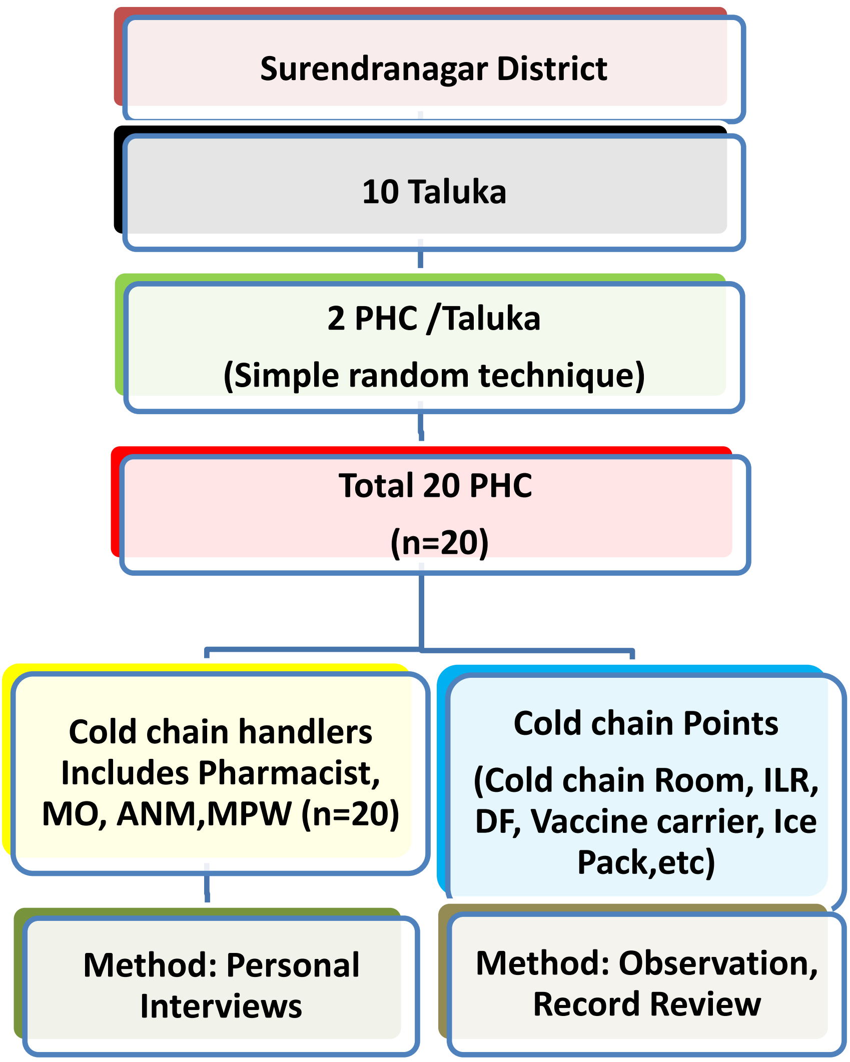


Figure 1: Flow chart of Material Methodology

Result: Data were collected from 20 selected PHC of Surendranagar district. One Cold chain handler Interviewed and One cold chain point Observed from each PHC.

Table 1 Sociodemographic profile of cold chain handler

AGE	Freq	%
20-29	3	15%
30-39	14	70%
40-50	2	10%
>50	1	5%
SEX	Freq	%
FEMALE	7	35%
MALE	13	65%
DESIGNATION	Freq	%
FHS	1	5%
FHW	2	10%
MEDICAL OFFICER	1	5%
PHARMACIST	16	80%
EDUCATION	Freq	%
ANM	3	15%
B Pharm	10	50%
M Pharm	6	30%
MBBS	1	5%

The study population contains individuals across various age groups, with the majority of study participate (70%) aged 30–39 years, followed by 15% in the 20–29 age group. In terms of sex distribution, 65% are male and 35% are female. Professionally, pharmacists constitute the largest group (80%), while Female health Workers (10%), Female Health

Supervisors (5%), and Medical Officers (5%) form the remaining workforce. Regarding educational qualifications, 50% hold a Bachelor of Pharmacy (B. Pharm) degree, 30% have a Master of Pharmacy (M. Pharm), 15% possess an Auxiliary Nurse Midwife (ANM) qualification, and 5% hold an MBBS degree.

Figure 2 Availablity of Medical officer at CCPs (n=20)

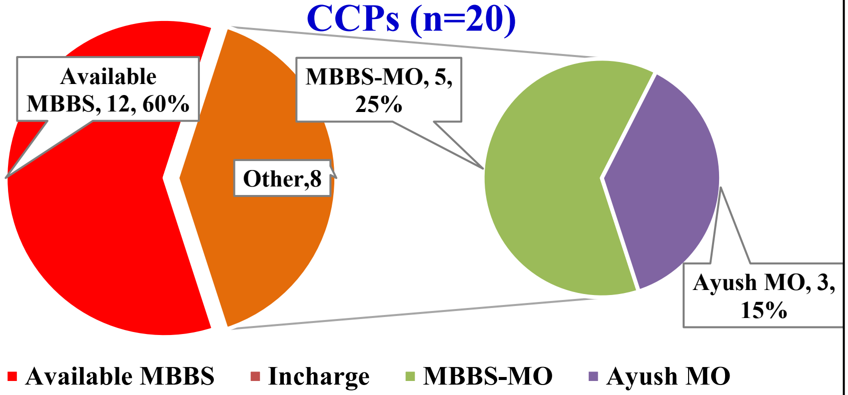
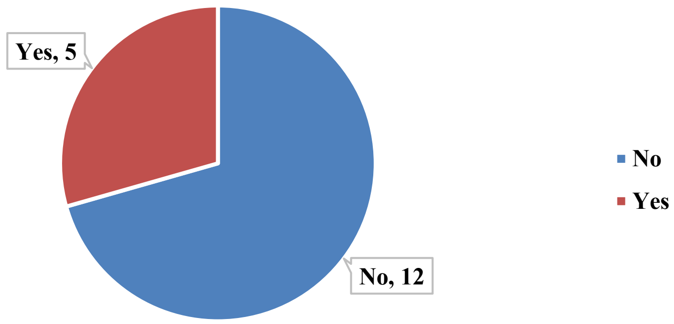


Figure 3 Medical officer (MBBS) trained in last 3 year on RI (n=17)



The pie chart and table illustrate the availability of medical officers at CCPs (n=20). The majority (60%) are available MBBS doctors (n=12), while in-charge medical officers make up 40% (n=8). Among the medical officers, MBBS-MO constitute 25% (n=5), whereas AYUSH-MOs account for 15% (n=3).

The pie chart illustrates the training status of (MBBS) medical officers on Routine Immunization (RI) over the past three years (n=17). A majority (71%) of medical officers did not receive training (n=12), while only 29% were trained (n=5). This data highlights a gap in RI training among medical officers, indicating the need for enhanced training programs.

Figure 4 PHC Microplan for RI (n=20)

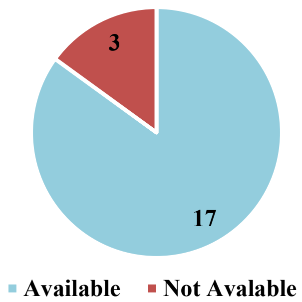
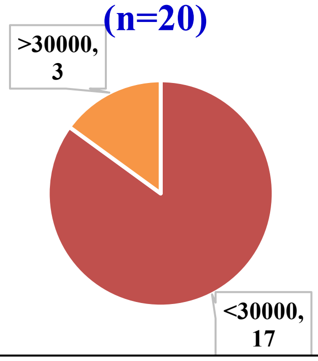


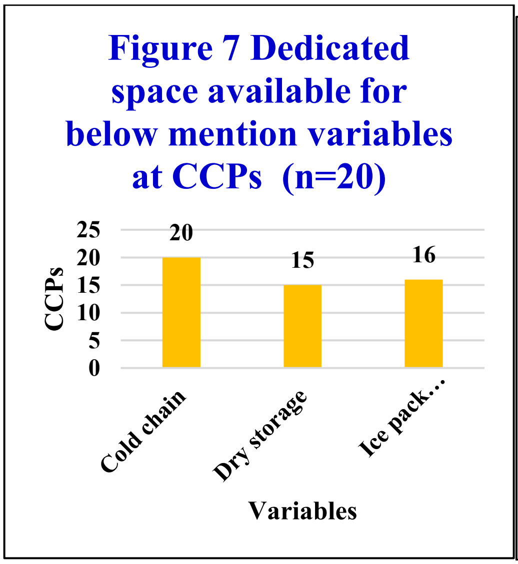
Figure 5 Population covered by CCPs (n=20)

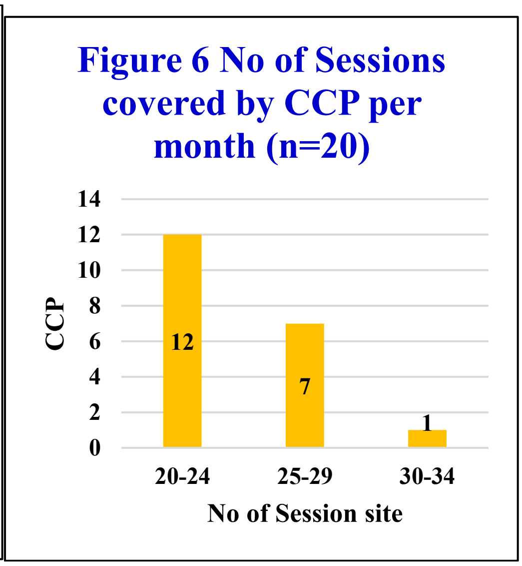


The Pie chart (Figure 4) illustrates the availability of PHC Micro plans for Routine Immunization (n=20). Majority (85%) of PHCs have an available micro plan (n=17), while 15% lack one (n=3). This data highlights a strong implementation of micro plans across most PHCs though a small proportion still requires attention to ensure comprehensive planning.

The pie chart (Figure 5) illustrates the distribution of population coverage by Cold Chain Points (CCPs)(n=20). The data is categorized into two groups: Covering a population less than 30,000 and those covering more than 30,000.

The majority of CCPs (85%) covered less than 30,000 population while (15%) 3 CCPs greater than 30,000 which may suggest either a higher demand on vaccine logistics or efficient distribution systems in these regions.





The chart (Figure 6) represents the distribution of session coverage by Cold Chain Points (CCPs) per month (n=20). The majority (60%) of CCPs conduct 20 to 24 sessions per month (n=12), while 35% (n=7) cover 25 to 29 sessions. A minimal proportion (5%) of CCPs conduct 30–34 sessions per month (n=1). These findings indicate that most CCPs operate within the 20–24 session range, with a decreasing trend observed as the number of sessions increases.

The chart (Figure 7) depicts the availability of dedicated space for Cold Chain, Dry Storage, and Ice Pack Conditioning at 20 Cold Chain Points (CCPs). Cold Chain storage is available at all 20 CCPs (100%), while Dry Storage is allocated in 15 CCPs (75%) and Ice Pack Conditioning in 16 CCPs (80%). The data highlights that Cold Chain storage is the most widely available, whereas Dry Storage is not available at some places (CCPs).

Table 2 Maintenance of ILR in CCP (n=20)

Maintenance of the ILR according to cold chain guidelines	CCPs	%
In the cold chain room, the ILR is placed away from sunlight and rain	20	100%
In the cold chain room, the ILR is placed on a stand	20	100%
In the cold chain room, the gap between the ILR and the side walls is 10 cm	20	100%
In the cold chain room, a gap is present between the ILR and the CCE	19	95%
In the cold chain room, the ILR's frost is less than 5 mm	14	70%
In the cold chain room, the ILR has a separate functional logbook	19	95%
In the cold chain room, the ILR has a separate functional stabiliser	20	100%
ILR has Separate thermometer and Place perfectly	12	60%
In the cold chain room ILR temperature is maintained between +2°C and +8°C	18	90%
In the Cold chain room ILR/Kept Only UIP Vaccines	19	95%
In the Cold chain room in the ILR/Kept Domestic Products/Items	1	5%
In the Cold chain room in the ILR/Kept Domestic Products/Items	1	5%
*CCP=cold chain point *Here no of ILR =20 (all cold chain point has ILR)		

The (Table 2) showed analysis of ILR maintenance in the cold chain point (CCP) reveals a high level of compliance with standard cold chain guidelines. Critical parameters such as placement away from sunlight and rain, installation on a stand, and maintaining appropriate spacing (10 cm from side walls and a gap from Cold Chain Equipment) showed 95-100% adherence. the presence of a functional stabilizer (100%) and a separate logbook (95%) indicates proper record-keeping and operational efficiency. However, certain areas require improvement. Only 70% compliance was observed in maintaining frost levels below 5 mm, which can impact the refrigerator's efficiency. Furthermore, only 60% of ILRs had a properly placed thermometer, suggesting a potential gap in temperature monitoring. While 90% of ILRs maintained the required temperature range of +2°C to +8°C, the remaining 10% might pose a risk to vaccine potency. A concerning observation was the presence of domestic products in ILRs (5%), which violates standard immunization cold chain protocols. This practice could compromise the quality of vaccines due to potential temperature fluctuations or contamination.

Table 3 Criteria according to standard guidelines for Deep freezer (n=20)

Variables	CCPs	%
DF away from Sunlight Rain	19	95%
DF Placed on stand	20	100%
Proper gap between and side walls Present	17	85%
Proper gap between and other CCE present	17	85%
DF frost is less than 5mm	12	60%
DF has separate logbook	18	90%
DF has separate stabilizer	19	95%
Separate thermometer for DF placed perfectly	13	65%
DF maintains a temperature between -5°C and -25°C.	18	90%
DF Kept Domestic Products Items found due to visit	2	10%
*All CCPs have an own DF (n=20)		

The (Table 3) showed assessment of deep freezer (DF) management across 20 Cold Chain Points (CCPs) was shown in above table. Proper placement and protection measures were observed, as all CCPs (100%) placed the DF on a stand (according to standard Guidelines), and 95% ensured that the DFs were keep away from sunlight and rain to minimize external temperature fluctuations. Ventilation was also well-maintained, with 85% of CCPs ensuring adequate spacing between the DF, side walls, and other Cold Chain Equipment (CCE). Temperature regulation appeared effective, as 90% of DFs maintained the recommended temperature range of -5°C to -25°C. However, frost control remained a challenge, with only 60% of DFs having frost levels below 5 mm, indicating the need for better defrosting practices. At least 90% of CCPs maintaining a separate DF logbook and 95% using a separate stabilizer to prevent voltage fluctuations. However, only 65% of sites had a properly placed separate thermometer in the DFs, highlighting a gap in temperature monitoring. A significant concern was the improper use of DFs, as domestic products were found stored in 10% of cases, which could compromise vaccine and other items integrity and disrupt the cold chain system. In conclusion, while deep freezer management at CCPs is mostly in compliance with guidelines, improvements are needed in frost management, proper thermometer placement, and ensuring that DFs are used exclusively for vaccines to maintain optimal cold chain efficiency.

Table 4 Monitoring of logbook of Cold chain equipment's by designated officers at cold chain point of PHC (n=20)

Variables	CCPs	%
The logbook of the ILR has a remark by the Cold chain technician due to last three months' visit	7	35%
The logbook of the ILR has a remark by the Taluka health officer due to last three months' visit	9	45%
The logbook of the ILR has a remark by the district immunization officer due to last three months' visit	0	0%
The logbook of the deep freezer has a remark by the Cold chain technician due to last three months' visit	5	25%
The logbook of the DF has a remark by the Taluka health officer due to last three months' visit	7	35%

Assessment of cold chain equipment logbooks over the past three months (Table 4) revealed remarks in 35% of Ice-Lined Refrigerator (ILR) logbooks by Cold Chain Technicians and 45% by Taluka Health Officers. For Deep Freezers (DF), remarks were present in 25% by Cold Chain Technicians and 35% by Taluka Health Officers. Notably, no remarks were recorded by the District Immunization Officer for either ILRs or DFs. While block-level staff and technicians demonstrate partial engagement, the total absence of district-level oversight underscores a need for enhanced accountability and regular supervisory inspections.

Regarding vaccine conditions at Cold Chain Points (CCPs) (Table 4), 90% (18 CCPs) maintained valid expiry dates, whereas 10% contained expired vials—1 CCP (5%) with two expired vials and 1 CCP (5%) with three. Similarly, 90% of CCPs had fully readable labels, while 1 CCP (5%) had three unreadable labels and 1 CCP (5%) had six unreadable labels.

Table 5 Condition of opened vaccine vials in the ILR at cold chain points of the PHC (n=20)

Variables	CCPs	%
Opened vaccine vials are stored in separate box / zipper bag		
No	1	5%
Yes	19	95%
Date and time of opening is written on the vial		
No	0	0%
Yes	20	100%
All opened vaccine vials are of < 28 days duration, since opened		
No	0	0%
Yes	20	100%

*All opened vaccine vial is stored inside ILR of the all CCPs of PHC (n=20)

The (table 5) assessment of opened vaccine vials stored in the Ice-Lined Refrigerator (ILR) at Cold Chain Points (CCPs) of Primary Health Centres (PHCs) revealed strict adherence to storage protocols. Among the 20 CCPs surveyed, 95% (19 CCPs) properly stored opened vaccine vials in a separate box or zipper bag, with only one CCP failing to do so. Additionally, all CCPs (100%) ensured that the date and time of opening were clearly written on each vial, demonstrating compliance with monitoring guidelines. All opened vaccine vials at the CCPs were within the recommended 28-day usage period and were properly stored in ILRs, indicating good adherence to cold chain protocols and ensuring vaccine potency and safety.

Table 6 Availability of logistics and adherence to cold chain management guidelines CCPs (n=20)

Logistics	CCPs	%
Icepacks kept for freezing filled up to the mark and capped?	20	100%
Clean cloth available for wiping of Icepacks after conditioning?	16	80%
Chart / SOP on ILR / DF / Vaccine / Ice pack arrangements available?	20	100%
Emergency / Contingency plan visible?	19	95%

The (Table 6) assessment of cold chain logistics across 20 Cold Chain Points (CCPs) includes Ice pack management, availability of standard operating procedures (SOPs), and Emergency/contingency planning was depicted in the above table and graph.

Proper ice pack management was observed, with all CCPs ensuring ice packs were filled to the mark and capped, though only 80% had clean clothes for wiping ice packs after conditioning, suggesting room for improvement in handling practices. Additionally, all CCPs had charts or SOPs for Ice Lined Refrigerators (ILRs), Deep Freezers (DFs), vaccine storage, and ice pack arrangements, ensuring standardized protocols were followed. Emergency preparedness was high, with 95% of CCPs having a visible contingency plan, though achieving 100% compliance remains essential.

Table 7 Frequency of CCHs getting a Grade due to asking below mention question (n=20)

Score	None	Poor	Average	Good
Knowledge of cold chain handler regarding freeze sensitive vaccine	0	0	4	16
Knowledge of cold chain handler regarding Heat sensitive vaccine	0	0	2	18
Knowledge of cold chain handler regarding light sensitive vaccine	0	0	0	20
Knowledge of cold chain handler regarding which vaccine can stored below 0'c	0	2	0	18
Knowledge of cold chain handler regarding which vaccine can follow open vial policy	0	0	1	19
*Score from 12 sub questions *Likert score				

Poor	0-4
Average	5-8
Good	9-12

The table 7 presents the knowledge assessment of Cold Chain Handlers (CCHs) based 12 sub questions vaccine management questions with scores categorized as Poor (0-4), Average (5-8), and Good (9-12).

Cold Chain Handlers demonstrated strong knowledge in vaccine storage and sensitivity. All handlers 20 (100%) had good knowledge about light-sensitive vaccines, while 95% knew which vaccines follow the open vial policy. Additionally, 90% correctly identified heat-sensitive vaccines and understood which vaccines can be stored below 0°C. In terms of freeze-sensitive vaccines, 80% of handlers exhibited good knowledge, whereas 20% fell into the average category. A small portion (10%) had poor knowledge regarding vaccine storage below 0°C. Despite these strengths, areas for improvement remain, particularly in understanding freeze-sensitive vaccines, as 20% of handlers scored only average. Furthermore, 10% lacked sufficient knowledge about proper vaccine storage below 0°C. To ensure full compliance with standard guidelines, additional training is necessary to strengthen handlers' expertise in these critical areas.

Figure 8 Frequency of CCHs getting a Grade due to asking below mention question (n=20)

Score	None	Poor	Average	Good
Knowledge of Cold Chain Handler about "Shake test"	0	3	6	11

Knowledge regarding "VVM"	0	1	3	16
Knowledge regarding "Frozen vaccine"	0	0	9	11
Knowledge regarding correct temperature of DF and ILR	0	0	10	10
*Score from 4 questions *Likert score				

None	0
Poor	1
Average	2
Good	3

The table 8 presents the frequency of Cold Chain Handlers (CCHs) receiving different grades based on their knowledge in specific areas related to vaccine storage and handling. The table is divided into four columns representing different levels of knowledge:

None (No knowledge)
Poor (Low knowledge)
Average (Moderate knowledge)
Good (High knowledge)

The specific knowledge areas assessed include:
Shake Test – 3 (15%) CCHs had poor knowledge, 6 (30%) were average, and 11 (55%) had good knowledge.
Vaccine Vial Monitor (VVM) – 1 (5%) handler had poor knowledge, 3 (15%) were average, and 16 (65%) had good knowledge.

Frozen Vaccine – 9 (45%) handlers had average knowledge, while 11 (55%) had good knowledge.
Correct Temperature of Deep Freezer (DF) and Ice Lined Refrigerator (ILR) – 10 (50%) handlers had average knowledge, while 10 (50%) had good knowledge.

DISCUSSION

In the present study, 60% of Medical Officers (MOs) were full-time and 40% were in charge, compared to 73% full-time and 26% deputed reported by Pradeep et al. (2020)8. Most MBBS MOs in our study lacked Routine Immunization (RI) training, whereas 80% received training in Pradeep et al. (2020)8. RI micro plans were present in 85% of PHCs, lower than the 100% reported by Ajay et al. (2014)9. Furthermore, 85% of Cold Chain Points (CCPs) covered a population under 30,000, aligning with Pradeep et al. (2020), who reported an average coverage of 21,000 per CCP8. Monthly sessions (20–24 at 60% of CCPs) were comparable to the ~25 session sites reported by Pradeep et al. (2020)8.All CCPs (100%) had dedicated cold chain space, but dry storage (75%) and ice pack conditioning space (80%) were less frequent; Panika RK et al. (2019) reported 100% availability for cold chain and dry storage, but lower conditioning space (33.3%)10.For Ice-Lined Refrigerators (ILRs), 100% were positioned away from direct sunlight, placed on stands, and maintained a ≥10 cm wall gap, consistent with Pradeep et al. (2020)8 and Naik et al. (2014)11. Side-wall frost accumulation (<5 mm) was observed in 70% of ILRs, compared to 55% reported by Naik et al. (2014)12 and 100% by Mandal et al. (2011)12. Functional logbooks (95%) and stabilizers were broadly available, close to Pradeep et al. (2020) (100% logbooks)8 and higher than Panika RK et al. (2019) (66% stabilizers)10. Perfect ILR placement was 60% in our study versus 100% in Naik et al. (2014)11. ILRs maintaining target temperatures (+2°C to +8°C) reached 90% (vs. 100% in Panika RK et al.)10, and non-vaccine storage was low at 5% (vs. 10% in Naik et al.)11. For Deep Freezers (DFs), 95% were away from direct sunlight (vs. 90% in Naik et al.)11, and 100% were on stands, consistent with Pradeep et al. (2020)8 and Naik et al. (2014)11. Proper wall clearance was present in 85% of DFs, lower than the 100% reported by Pradeep et al. (2020)8 and Naik et al. (2014)11. Frost <5 mm was recorded in 60% of DFs (vs. 50% in Naik et al.)11. Operational compliance was high for separate logbooks (90%), stabilizers (95%), and thermometer placement (65%), though slightly lower than the 100% reported by Pradeep et al. (2020)8. Non-ice pack storage in DFs was low (10%), mirroring Naik et al. (2014)11. District-level supervisory visits in the last 3 months were lower in our study (35%) than in Pradeep et al. (2020) (87%)8. Regarding vaccine handling, 95% of CCPs stored opened vials in separate boxes/zipper bags, slightly below the 100% reported by Panika RK et al. (2019)10 and Ajay et al. (2014)8. Adherence to open vial policies (date/time labeled, <28 days duration) and proper ice pack filling/capping reached 100%, matching Panika RK et al. (2019)10. Clean cloths for wiping ice packs were available at 80% of CCPs. Standard SOPs for equipment/storage were present in 100% of CCPs, and visible contingency plans were present in 95%, mirroring high protocol adherence seen in Delhi (100% SOPs for ILRs/DFs, 78% for storage, 90% contingency plans)13. Vaccine handlers showed strong knowledge regarding light-sensitive vaccines (100%), open vial policies (95%), and heat-sensitive vaccines/sub-zero storage (90%). However, knowledge gaps were identified in freeze-sensitive vaccines (80% good, 20% average, 10% unaware of sub-zero needs), the Shake Test (55% good, 30% average, 15% poor), VVM interpretation (65% good, 15% average, 5% poor), frozen vaccines (55% good, 45% average), and DF/ILR temperature ranges (50% good, 50% average). Comparatively, a cross-sectional study in Ethiopia reported satisfactory knowledge in 53.5%, positive attitudes in 45.7%, and good practices in 48.8% of vaccinators, highlighting the need for continuous training to strengthen vaccine management expertise14.

CONCLUSION:

The present study evaluated the cold chain system in Surendranagar district to identify procedural and equipment-related gaps, determine influencing factors, and assess the knowledge of Cold Chain Handlers (CCHs). The findings showed that the cold chain system was generally functional and largely compliant with standard guidelines, particularly regarding equipment placement, temperature maintenance, vaccine storage, and immunization session planning. However, important gaps were identified, including inadequate power backup, limited adoption of the National Cold Chain Management Information System (NCCMIS), inadequate frost management, and insufficient dry storage and ice pack conditioning space at some Cold Chain Points (CCPs). Inadequate training of Medical Officers, particularly MBBS Medical Officers, and the lack of regular refresher training on Routine Immunization were also identified as factors affecting system performance. Although CCHs demonstrated good overall knowledge of vaccine storage and cold chain maintenance, deficiencies were observed in knowledge related to freeze-sensitive vaccines, temperature monitoring, and the shake test. Overall, the cold chain system in Surendranagar district was satisfactory, but strengthening infrastructure, ensuring uninterrupted power supply, improving digital system utilization, and providing regular capacity-building programs for healthcare workers are essential to enhance vaccine safety, maintain vaccine potency, and improve the quality of immunization services.

RECOMENDATION:

Regular refresher training should be provided to Medical Officers and Cold Chain Handlers, with emphasis on Routine Immunization, freeze-sensitive vaccines, temperature monitoring, the shake test, and emergency procedures. All Cold Chain Points (CCPs) should have reliable power backup, adequate dry storage, and sufficient ice pack conditioning space to ensure uninterrupted vaccine storage. Universal implementation of the National Cold Chain Management Information System (NCCMIS) should be promoted to improve real-time monitoring and data management. Regular monitoring and supportive supervision should ensure proper equipment maintenance, adherence to Standard Operating Procedures (SOPs), and timely correction of deficiencies. Contingency plans should be available and periodically tested at all CCPs, while recognizing high-performing CCPs and ensuring equitable workload distribution to improve overall cold chain performance and immunization service quality.

LIMITATIONS

This study was conducted at only 20 PHC of Surendranagar District of 20 Cold chain point using consecutive sampling, which may limit generalizability. The cross-sectional design does not allow causal inferences. All Cold chain point functionality was assessed at a single point in time and may not reflect seasonal or supply-chain variability.

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CONFLICT OF INTEREST

None declared.

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REFFERENCE

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