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Short Communication

Barriers and enablers to implementing point-of-care testing for anaemia diagnosis in pregnancy among healthcare workers in North Goa, India

Utkarsh Betodkar[1], Reetika Malik Yadav[1], Sridhar Lakshmipathy[2], Janani Surya[1], Joshua Chadwick[1]*

[1]Indian Council of Medical Research National Institute of Epidemiology, Chennai, Tamil Nadu, India
[2]Directorate of Health Services, Goa, India

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***Correspondence:**
Dr. Joshua Chadwick,
E-mail: joshuachadwick89@gmail.com

ABSTRACT

Globally one fifth of the world's population is affected by anaemia, with pregnant women being among the worst affected. In India, including Goa, anaemia prevalence among pregnant women has worsened per national family health survey (NFHS-5), prompting the launch of the Anaemia Mukt Bharat program. One key intervention was the provision of digital hemoglobinometers at sub-centres for point-of-care testing (POCT). Despite investments, implementation of POCT for anaemia diagnosis among pregnant women in Goa remains limited. This descriptive qualitative study was conducted in sub-centres of North Goa equipped with digital hemoglobinometers to understand enablers and barriers to POCT implementation. From December 2023 to April 2024, 11 in-depth interviews were conducted with healthcare workers and a state program officer. Data was analysed using thematic analysis guided by the consolidated framework for implementation research (CFIR). Three key enablers were identified: availability and benefits of digital hemoglobinometers, decentralized procurement, and strengthened health information systems. Healthcare workers valued the POCT devices for their ease of use and portability. However, barriers included staffing shortages, inconsistent supply of consumables, technical malfunctions, and limited opportunities for testing due to low patient follow-up. The lack of formal training and quality assurance also affects implementation. Digital hemoglobinometers have simplified anaemia testing at sub-centres, but administrative, logistical, and technical barriers hinder effective implementation. Addressing these challenges through consistent supply chains, formal training, and quality assurance can improve the utilization of POCT for diagnosing anaemia in pregnant women. Strengthening follow-up care and routine haemoglobin testing during antenatal visits is vital to reduce anaemia among this vulnerable population.

Keywords: Anaemia, Digital hemoglobinometer, India, Pregnancy, Sub-centre

INTRODUCTION

Globally one fifth of the world's population is affected by anaemia, prevalence being highest among preschool-age children (40%) and women in the reproductive age-group (30%).[1,2] In India, over half of women in the reproductive age group are anaemic, with anaemia in pregnancy being a notable concern.[3] The prevalence of anaemia in pregnancy in Goa state increased substantially from 27% to 41%, reported by NFHS 4 and 5 respectively. to address the problem of increasing prevalence of anaemia, National program on prevention and control of anaemia (Anaemia Mukt Bharat program) was launched in 2018. The program aims to reduce the prevalence of anaemia by 3% annually among six vulnerable groups comprising of under-5 and five- to ten-year-old children, adolescents, women in the reproductive age (15-49 years), pregnant and lactating women.[4] Iron deficiency is the commonest

micronutrient deficiency, accounting for over 3% of all disability-adjusted life years (DALYs) lost.[2,5] Anaemia in pregnancy is a common medical condition usually managed by general practitioners. Early diagnosis is crucial for appropriate and timely management. The ideal method for haemoglobin estimation is the use of venous blood, analysed on automated haematology analysers. Use of portable hemoglobinometers for anaemia screening provides an opportunity for early diagnosis especially in field settings.[6,7] The Government of India is committed to the world health assembly's target of 50% reduction in anaemia among women of reproductive age by 2025.[8,9]

Evaluation of implementation of Anaemia Mukt Bharat program (AMB) in Goa revealed that inadequate testing for anaemia could be responsible for increasing prevalence of anaemia in pregnancy in the state. To address this gap of haemoglobin testing in pregnancy, the state program rolled out POCT in phased manner in peripheral public health facilities in North Goa as per national guidelines. Despite the substantial investment, the POCT use is not widely implemented. Our study aimed to explore the enablers and barriers to effective implementation of POCT for diagnosing anaemia in pregnancy, from provider perspectives at peripheral public health facilities of North Goa, India.

METHODS

Study design

This was a cross-sectional qualitative study. CFIR model was utilised for thematic analysis in this study.[10] CFIR was selected to systematically evaluate determinants across 5 domains: intervention characteristics, outer/ inner settings, individual roles, and process.

Study setting

Study was conducted in North Goa district, India. As of 2024, North Goa infrastructure entails 1 state cell, 1 district hospital, primary health care facilities (PHCs) (n=13), and peripheral public health facilities (subcentres) (n=113), that provide testing and treatment services for anaemia. Treatment services are mostly offered at PHCs level and above, including routine antenatal care for pregnant women, whereas sub-centres mainly provide supportive care including registration, immunization and haemoglobin testing and referral for pregnant women. Sub-centres equipped with functional digital hemoglobinometer chosen for this study. This device is used as POCT tool at the sub-centre level to test anaemia among school-going adolescents, pregnant women and other individuals who seek care at sub-centres.

Study population

From December 2023 to April 2024, all health care workers (Auxiliary Nurse Midwife (ANMs)/multipurpose health worker-male (MPHW (M)) at the sub-centres formed a convenient, accessible sample for this study.

Sampling strategy

The sampling approach for this study utilized purposive sampling to select 10 sub-centres out of the total 113 in North Goa, choosing these facilities based on their performance in haemoglobin testing using digital hemoglobinometers-specifically, a mix of good, fair, and poor performers to ensure a representative range of experiences.

Inclusion criteria

From the selected sub-centres, healthcare workers with more than six months of service experience-comprising nine auxiliary nurse midwives (ANMs) and one MPHW-M-were chosen for in-depth interviews. Additionally, to provide a broader programmatic perspective, the state program manager for reproductive, maternal, newborn, child, adolescent health and nutrition (RMNCAH+N) in North Goa was included in this study.

Exclusion criteria

Healthcare workers on long leave or unavailable during the study period (December 2023-April 2024) and healthcare workers unwilling to participate or those who did not provide written informed consent were excluded.

Data collection

In-depth interview (IDI) method was used to collect the data. CFIR guided interview design and analysis, and an interview guide was prepared and validated. Audio recorded device was used to record the interview by the principal investigator trained in qualitative research at a time convenient to the study participants. Data was collected after obtaining permission and written informed consent from the study participants. No incentives were provided to participate in the study.

Interviews were conducted by principal investigator in native language (Konkani). Audio recording and verbatim notes were taken during the interviews. After the interview, the summary of findings was read back to the participants to ensure participant validation. Additionally, a second investigator reviewed the verbatim notes to reduce bias and increase interpretive credibility.

The investigators work in at national public medical research institute, and the principal investigator (State surveillance officer) was not operationally involved in the Anaemia Mukt Bharat program, minimizing potential conflicts of interest. As a member of the State health system primarily focused on infectious diseases, the investigator's familiarity with public health operations in Goa provided contextual understanding but could also introduce assumptions about healthcare worker

experiences. To mitigate potential bias, interviews were conducted in the participants' native language, and summaries were validated with participants. The research team, comprising public health professionals and scientists from a national research institute, regularly reflected on their own assumptions and positions throughout data collection and analysis to ensure rigor and transparency in interpretation.

Data triangulation was ensured by collecting data from healthcare workers with different levels of experience and from various geographical locations. We also interviewed State program officer who is in-charge of RMNCAH+N. Complete anonymity and confidentiality of the participants data was maintained throughout the study period. The research team consisted of trained qualitative researchers with backgrounds in public health and experience in conducting interviews in similar settings; their roles, credentials, and potential biases were documented and considered throughout the study. Reflexivity was maintained by regular team discussions and reflexive journaling, acknowledging how the researchers' backgrounds and perspectives might influence data collection and analysis. Interviews were conducted using a semi-structured guide, audio-recorded with participants' consent, and transcribed verbatim. All participants provided informed written consent, and confidentiality was ensured by anonymizing data and securely storing transcripts. Data analysis followed a thematic approach, with initial coding conducted by two independent researchers to ensure reliability; emerging themes were discussed and refined by the research team, and participant validation was used to confirm interpretations in line with COREQ guidelines.[11]

Data management and analysis

Following each interview, the audio recordings and verbatim notes were translated in English language and then transcribed within one month of data collection by the principal investigator. The transcripts were read by two investigators, and drafted a manual descriptive thematic analysis of the transcripts independent of each other. A third investigator reviewed the same data for content validity. Data were coded using Microsoft excel 2016 as well in ATLAS.ti 9 software. All coding differences were reconciled by consensus. Grouping was carried out in ATLAS.ti 9 software and then manually arranged under various themes and subthemes as per CFIR (Figure 1).[10]

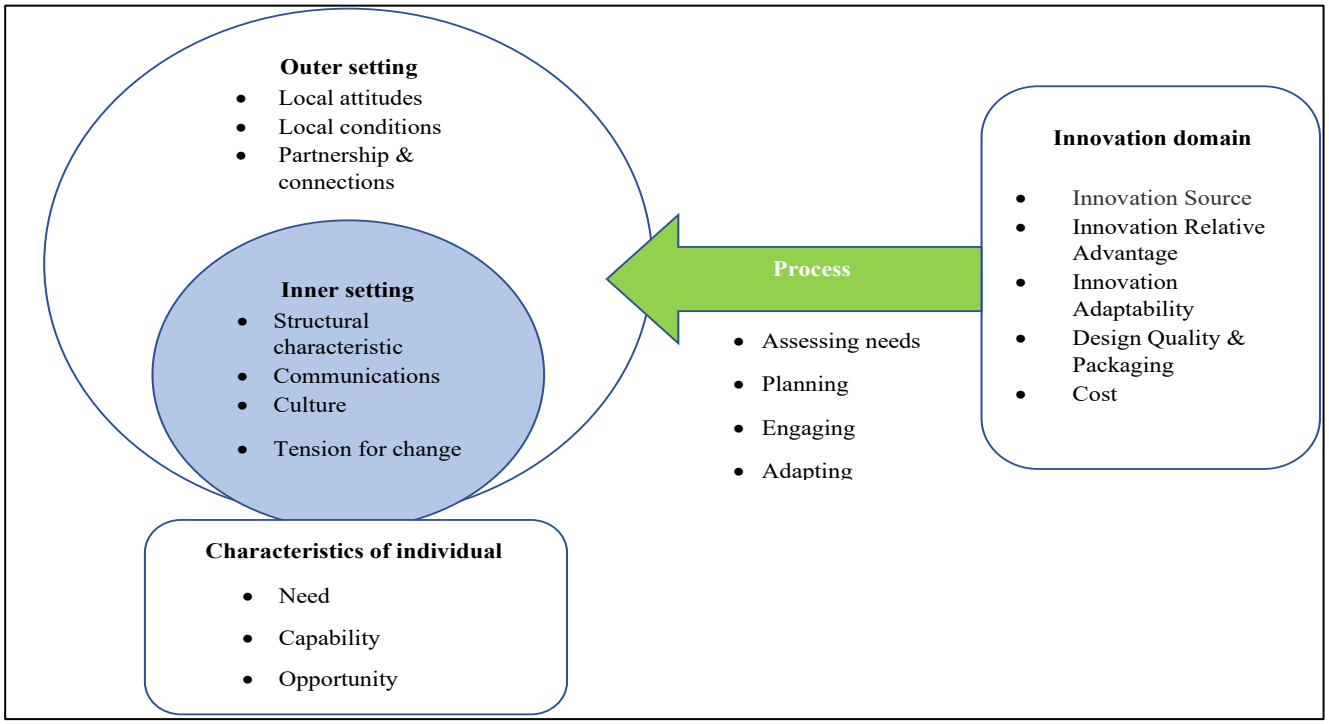

Figure 1: CFIR.

RESULTS

A total of 11 in-depth interviews were conducted. Of these, ten were with healthcare workers at sub-centre and one with state program officer, RMNCAH+N (Table 1). We present the results in three separate parts: perceived enablers, perceived barriers and then suggested solutions (Figure 2).

Perceived enablers

We identified 21 themes which were broadly classified into three major categories, 'POCT availability and advantage over previous equipment', 'Decentralised procurement of POCT' and 'Health information system advancement and operational planning' (Figure 3).

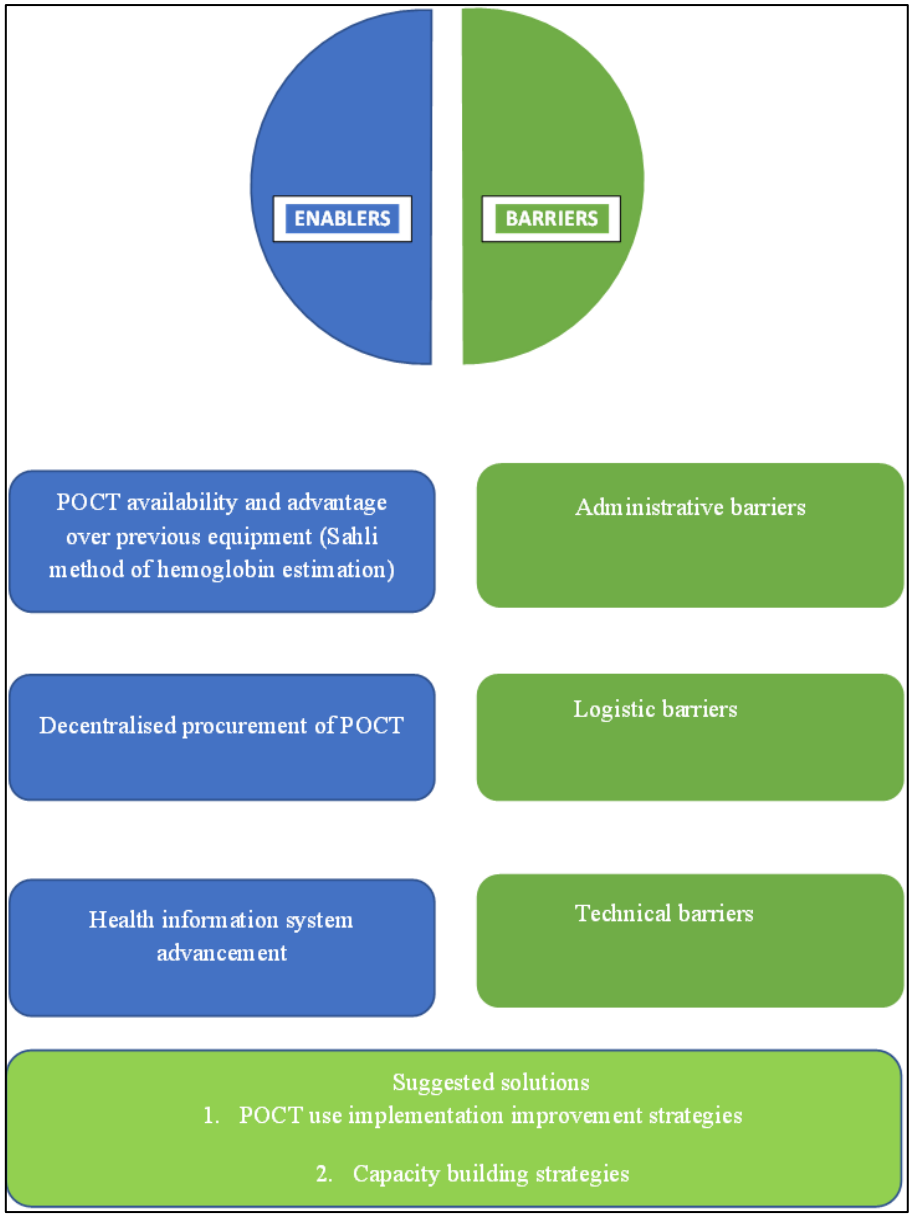

Figure 2: Perceived enablers, barriers and suggested solutions on implementation of POCT for diagnosing anaemia in pregnancy in North Goa, India 2024.

Table 1: Study participant characteristics and duration of interviews.

Interview type	Designation	Experience in that position (in years)	Duration of interview (in min)
Key informant interviews-in person	ANM (n=9)	17	50
		17	34
		17	27
		12	33
		12	49
		12	37
		5	55
		5	50
		2	46
	MPHW (n=1)	28	50
	State program officer (n=1)	1	20

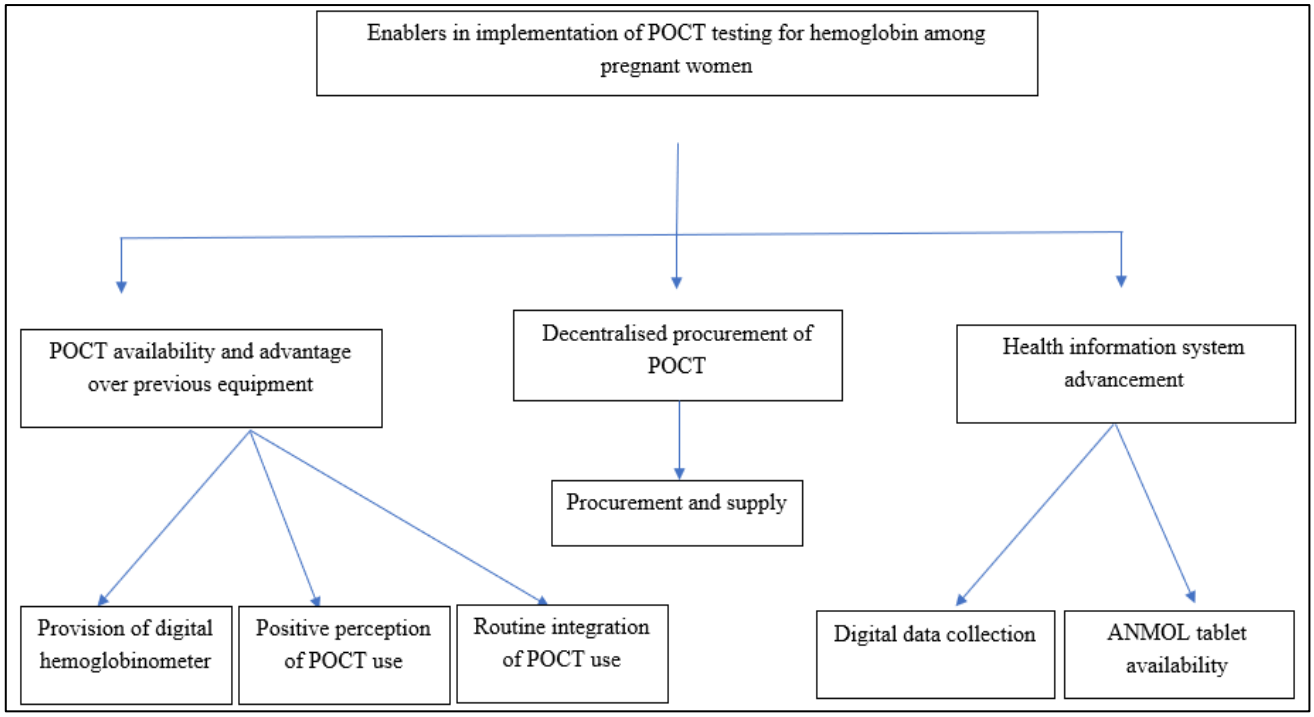

Figure 3: Thematic analysis showing enablers as perceived by AMB staff in implementing POCT for hemoglobin among pregnant women in North Goa, India, 2024.

POCT availability and advantage over previous equipment

Four themes were categorised here, 'provision of digital hemoglobinometer', 'positive perception of POCT use', 'routine integration of POCT use' and 'self-learning in use of POCT'.

Provision of digital haemoglobinometer

Digital hemoglobinometer (POCT) was provided to all sub-centres under the Anaemia Mukt Bharat program. Initially haemoglobin testing was carried out at medical college, district, sub district hospitals, and community health centres and now haemoglobin POCT implanted at the sub-centre level. This innovation was rolled out as one of the interventions under this program in order to provide haemoglobin testing facility to pregnant women, adolescents and high-risk groups.

"Anaemia is definitely a problem in pregnant women in Goa too….. As per NFHS 5, Anaemia prevalence is increased in Goa from the figures seen in NFHS 4….. But looking at the state reports it seems to be lesser than what is said in NFHS 5….. But any way, the problem is there. In order to understand the situation Goa medical college has already started a study to find current prevalence of anaemia in Goa state. Same time even NFHS team is in Goa and my medical officer is co-ordinating with their team." (State program officer, RMNCH+A).

No sooner these digital hemoglobinometer were supplied to the sub centres all sub-centres started testing for Hb reflecting the 'positive perception of POCT use'. Many respondents said that this digital equipment was more practical, easy to use and provided results more quickly than the past equipment (Sahlis method). Also, the past equipment depended more on proper mixing of reagents, good light for colour codding and was complex and time consuming.

"There was this Sahlis hemoglobinometer which I remember were available 10 years back and testing used to happen with this equipment. But it was time consuming and needed to be done in good light for colour coding so this particular digital hemoglobinometer is more practical". (ANM, 12 years' experience).

"Yes, Sahlis hemoglobinometer was used in past. During my previous posting I have been using… It was little difficult…. was time consuming… This new equipment is easy and we can do test faster" (MPHW Male, 28 years' experience)

Digital hemoglobinometer is 'integrated in routine services' provided at sub-centre. Respondents said that the equipment's design and packaging is such that it is portable and hence this service is made available at various outreach locations like village health sanitation nutrition days (VHSNDs), schools, camps, old age homes, construction site other than testing at sub-centre. This service is available for pregnant women, adolescents, and patients attending OPDs.

"I don't think there is any problem initiating the testing…..My requirement is around 100 strips per month

as I do testing at my old age homes, ANC, general OPD as well at various outreach programs. Like last month we had anaemia Mukt Bharat activity where we did Hb testing for people gathered there". (ANM, 12 years' experience).

Respondents said the provided digital hemoglobinometer equipment was easy to use and was practical, highlighting the 'Self learning in use of POCT'. They even said that although no training was conducted at the primary health centre level, they could still learn themselves as it was easy. Some said they used literature leaflet which came with equipment while some said it was similar to glucometer test already available at the centre.

"We test it as it is same as glucometer". (ANM, 2 years' experience)

"No sir, no training was conducted, we started testing on this equipment ourselves referring to the leaflet which came with the equipment. I don't think there is any problem initiating the testing". (ANM, 12 years' experience).

Decentralized procurement of POCT

For the ease of procurement and supply this was decentralized to primary health centre (PHC) level. All sub-centres were supplied with digital hemoglobinometer by respective PHCs.

"Hb testing was done in all district and sub district hospitals, CHCs, PHCs…and now we have rolled out Hb testing at sub-center level with digital hemoglobinometer…All centers are provided with digital hemoglobinometer by their respective PHCs…They can now test pregnant women, children and others at sub-centers as well as in other outreach programs like VHNDs". (State program officer, RMNCAH+N).

Health information system advancement and operational planning

All selected sub-centres had provision of tablet for digital data collection and uploading. ANMOL (ANM online) tablets are provided to all sub-centres for data uploading on various portals of national programs. Respondents said that various information regarding pregnant women is uploaded on RCH portal however all sub-centres also maintain a register on pregnancy line list along with required information which includes information on haemoglobin. This was based on codes such as 'ANMOL availability', 'maintaining of physical register', 'online reporting' and 'online portal'.

"*We reported 36 ANCs this year out of 40 ANC target given ….. Information on all these 36 pregnant women is written in ANC register as well on RCH portal through ANMOL".* (ANM, 2 years' experience).

Perceived barriers

We identified 21 themes which were broadly classified into three major categories, 'administrative', 'logistic', and 'technical' (Figure 4).

Administrative barriers

Although there is weekly monitoring for haemoglobin testing as well as reproductive and child health component however respondents said that barriers at ground level were never addressed. Most respondents spoke about staff vacancy at sub-centre level and a few places permanent staff deployed at other places.

"We currently do weekly reviews of Anaemia Mukt Bharat at state level by calling 2 to 3 PHCs every week. In these meetings complete monitoring is done along with other indicators under RCH". (State program officer, RMNCAH+N A).

"This year it was difficult because past 10 months I was handling this centre alone….. as MPHW male expired 10 months back….I had to work alone since than…..I had to even visit construction sites …..Now I have got bond ANM for last one month". (ANM, 12 years of experience)

Logistic barriers

Four themes were identified in this category, 'Opportunity to test', 'understaff', 'training of staff' and inconsistent supply of consumables.

Opportunity to test

Very few pregnant women visited sub-centres hence respondents said that there is less opportunity to test them. Also, most of the pregnant women follow up at higher centres, but they are tested only once. Pregnant woman gets retested only if she is anaemic. Retesting is seen more in private than in government hospitals.

"That's what I told you doctor at district hospital they will retest for pregnant women only if they find her to be anaemic… or if she was anaemic before then a follow up testing happens". (ANM, 12 years of experience).

"Most of them will visit district hospital and very few will visit PHCs…. as gynaecologist visit only once a month at PHCs….. also, the transport from this area to PHCs is more difficult than going to district hospital district hospital….People have to change two buses in order to reach PHCs but to go to district hospitals there is a direct bus from here…..I have few anaemic pregnant women and most of them will follow up only at district hospital". (ANM, 12 years of experience).

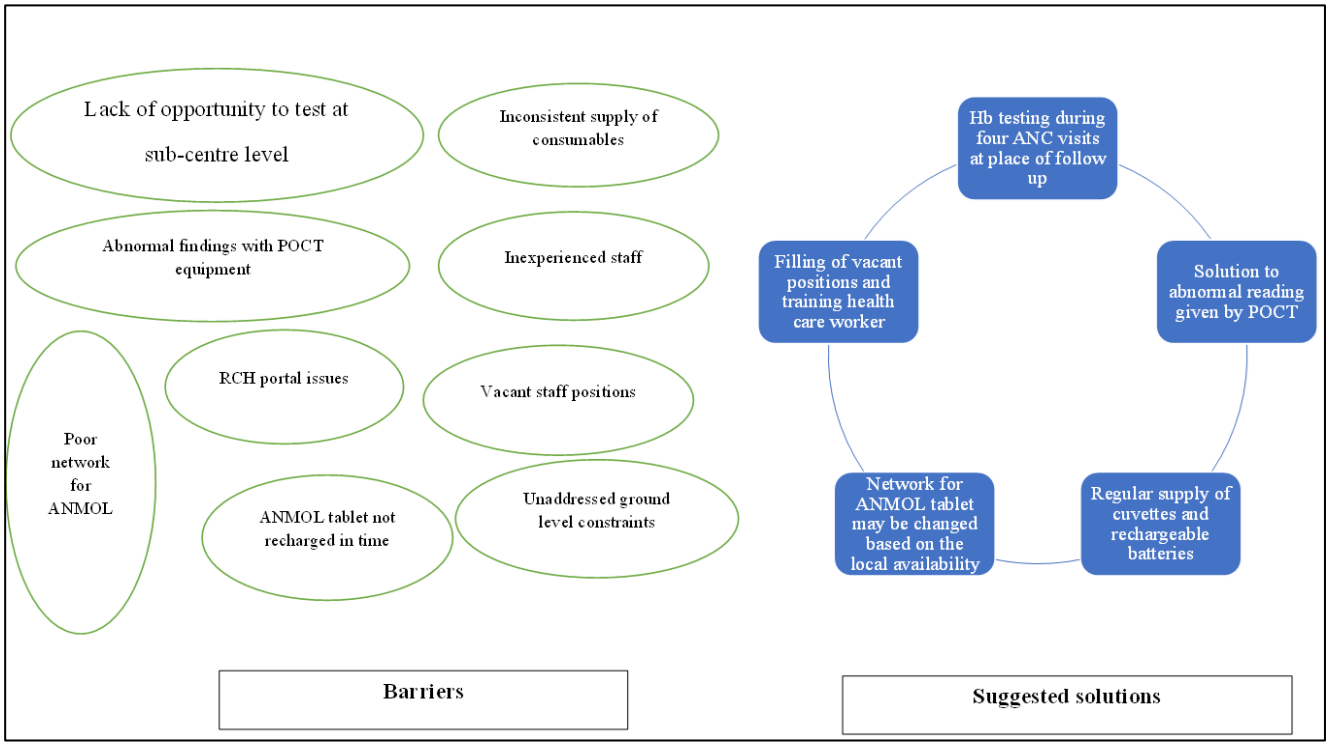

Figure 4: Providers' perspectives into barriers and suggested solutions to improve anaemia management for pregnant women in North Goa, India (2024), in relation to anaemia testing using hemoglobinometer.

Understaff

Most sub-centres are adequately staffed with two posts of MPHW(M)/ANM and a helper, however most of the centre second MPHW(M) or ANM is either contract staff or a bond staff. Other issues are untrained staff, permanent staff deployed to other health care centres, female staff on place of MPHW(M), frequent change of temporary staff. Respondents also said that POCT along with other jobs under all national programs cannot be finished in given time and human resource and hence difficult to provide POCT during Immunization days, VHNDs, and during outreach sessions with available resources.

"We are two ANMs….. One is permanent and one on bond….. Other permanent ANM post is deployed to other centre. I am actually on a post of MPHW male….and we have one helper". (ANM, 2 years' experience).

"I can do testing of haemoglobin every 2 to 3 months to increase 4 time testing of haemoglobin in pregnancy....One of the contact point of pregnant women is when they come for immunization....but as this happens along with general immunization where beneficiaries are more than 40-50 It's difficult to give even haemoglobin testing service….. Maybe if we get additional staff on vaccination days we can even provide haemoglobin testing facility.....Same happens during outreach sessions for vaccination" (ANM, 12 years' experience).

Training of staff

Respondents said that no formal training is conducted in Hb testing and anaemia management. They also said that in case of anyone with anaemia they are not authorized to treat anaemic patients. No guidelines or SOPs were shared with sub-centres.

"Training was only about how to test on the machine, which was once shown to us by lab technician from the PHC....no other details were taught to us….I know to use this equipment as my sister is a laboratory technician". (MPHW, 28 years of service).

"No sir, no training was conducted….. we started testing on this equipment ourselves referring to the leaflet which came with the equipment.....I don't think there is any problem initiating the testing" (ANM, 12 years' experience).

Inconsistent supply of consumables

As procurement and supply were decentralized different PHCs have supplied POCT equipment with different specifications. Some respondents also said that consumables like test cuvettes are not supplied on time where as some said consumables like batteries are not provided for equipment.

They had to pay for batteries from their pocket and there are issues with reimbursement.

"Last month we were asked to do testing of haemoglobin for women on a campaign mode, but cuvettes were not available for that month". (ANM, 2 years' experience).

Technical barriers

Most of the respondents said that the POCT equipment gives very low HB values even in asymptomatic patients. This issue has been informed to the higher authorities but no satisfactory solution has been given.

Other issues are with reporting with ANMOL tablet like, Poor network, equipment hanging, loss of entered data, not recharging tablet on time by PHC.

"Currently we have an issue with the equipment…..as equipment is showing very low reading for almost all the patients….Even today for one patient when we check the reading was 7.2, and when we check she was not even having pallor…..So I repeated for one of our staff, with known Hb, but with this machine it was still showing abnormal". (ANM, 12 years in service).

"Yes we have our ANMOL tablet…..but we suffered because of poor range of xxx network…..every day while uploading data on various online portals we suffer because of network…..we even try using our own mobile networks, by keeping our phones on windows, outside the centre searching for good range for network…..even on immunization day one person has to seat outside the centre in search of a good network and upload the data' (ANM, 12 years of service).

Suggested solutions

The respondents suggested the following solutions (Figure 4).

POCT use implementation improvement strategies

Haemoglobin testing during ANC visits

Ensure haemoglobin (Hb) testing is conducted during all four ANC visits at the point of follow-up.

Addressing abnormal readings from POCT

Communication is sent to higher authorities about problem with the equipment especially abnormal readings. They suggested that either such equipment needs to be replaced or must be corrected immediately.

Ensuring regular supply of consumables

Maintain a consistent supply chain for essential consumables such as cuvettes and rechargeable batteries for digital hemoglobinometer.

Network for ANMOL tablet may be changed based on the local availability and same needs to be recharged regularly.

Filling vacant positions

Respondents suggested that the recruitment and retention of skilled healthcare workers in sub-centres can enhance the overall efficiency of healthcare services, including the implementation of POCT.

Capacity building strategies

Training of health care workers on POCT with digital hemoglobinometer and on anaemia management.

Simplifying anaemia management protocol

Develop simplified and clear protocols for the management of anaemia. These suggested strategies aim to improve the implementation of POCT as well as build the capacity of healthcare workers, ultimately enhancing the quality of antenatal care provided to pregnant women.

DISCUSSION

The introduction of digital hemoglobinometers has greatly simplified the screening for anaemia. These devices are cost-effective, convenient, user-friendly, and offer rapid results, thereby strengthening the coverage for anaemia testing compared to traditional methods such as the Sahli's method of haemoglobin estimation.[12] Digital hemoglobinometers exhibit high sensitivity and specificity, making them a promising option for POCT in screening for anaemia at peripheral health facilities.[1] With an ambitious goal to reduce the prevalence of anaemia in Goa among six vulnerable target groups, one key intervention was the implementation of digital hemoglobinometers.[4]

The digital hemoglobinometer has been accepted well by the health care workers, being easy to use and portable as compared to the previous Sahli method of haemoglobin estimation.[12] Despite the lack of formal training, healthcare workers adapted to using the digital hemoglobinometers effectively, mostly by self-learning and using the literature available with the equipment.

The portable design of digital hemoglobinometer facilitates conducting for outreach sessions at construction sites, village health and sanitation nutrition days, as well as schools. However, it is also necessary to note that the lack of electricity in the field setting and the need to provide frequent new set of batteries may hinder its routine use for the target population. The participants' suggestion to use rechargeable batteries and, consequently, addressing the issue of power supply is essential because it is bound to affect the feasibility of using POCT devices at different locations.

This study uniquely identifies supply-chain vulnerabilities (e.g., battery shortages) in decentralized procurement systems-a gap overlooked in national guidelines but critical for sustainability. The digital hemoglobinometers occasionally give incorrect results, displaying unusually low haemoglobin levels in patients without symptoms. A study identified type of instrument, ensuring external and internal quality assurance, performing 10 or more tests weekly, and having laboratory-qualified personnel perform the tests to be associated with good performance in Hb testing with POCT.[13] With majority of pregnant women seeking antenatal care at higher centres, the opportunity for Hb estimation at sub-centres are few beyond registration of their pregnancy. As per NFHS round 5, mothers who had at least four total antenatal visits is 91.3 percent for North Goa, hence focus should be on implementing regular testing during follow up visits at PHCs and higher centres.[13]

The study's strengths include the use of the CFIR to systematically explore enablers and barriers to POCT for anaemia in pregnancy, providing a robust theoretical foundation for analysis, and the inclusion of multi-level stakeholder perspectives from both frontline healthcare workers and a state program officer, which enriched the depth and practical relevance of the findings. Data triangulation through interviews with participants of varying experience and from diverse geographical locations, as well as participant validation of interview summaries, further enhanced the reliability of our results. However, the study is limited by its focus on healthcare providers and program managers, which excludes the perspective of pregnant women and other end-users-a crucial limitation that constrains a holistic understanding of POCT utilization. Additionally, the sample size was relatively small and drawn exclusively from sub-centres with functional digital hemoglobinometers, potentially limiting generalizability to other settings or to centres without such devices. The study's single-region focus in North Goa and lack of quantitative data on the extent of POCT use or its impact on anaemia prevalence further constrain the breadth of the findings. Despite these limitations, the study offers valuable insights into the operational challenges and opportunities for strengthening anaemia diagnosis in pregnancy through POCT at the sub-centre level

CONCLUSION

We observed that the use of digital hemoglobinometers at the sub-centre level sub-optimal in North Goa with major gaps in the extent of testing the eligible pregnant women. This qualitative study explored the enablers, barriers and suggested solutions in improving the diagnosis and management of anaemia from AMB staffs' (perspective). These devices provide several advantages over traditional method of haemoglobin estimation, such as ease of use, portability, and rapid results, which have led to their acceptance by healthcare workers. However, a collaborative approach that addresses challenges like opportunity lost for getting tested at sub-centre, occasional inaccurate results, lack of electricity, in field settings and the frequent need for new batteries affect feasibility of their use. This study advances understanding of the practical challenges in implementing point-of-care anaemia testing in peripheral health facilities.

These insights provide evidence to inform programmatic strategies under the anaemia Mukt Bharat initiative, particularly the need for system-level solutions such as quality assurance mechanisms, improved supply-chain management, and integration of testing at higher levels of antenatal care. Addressing these factors will be essential to optimize the role of digital hemoglobinometers in strengthening anaemia screening and improving maternal health outcomes.

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