

## **An Operations Research Study on Point of Care Testing for Sickle Cell Anemia**

**Background:** Sickle Cell Disease is a major public health problem in India. State of Chhattisgarh has very high prevalence of Sickle Cell Disease cases, estimated at 0.5% to 1.2% of population (Patra, 2011). The disease causes severe morbidity and disability (Orlando et al, 2000). A majority of patients of Sickle Cell Disease (SCD) face recurrent episodes of severe pain, often from their childhood. The disease causes high mortality in young age. It is a source of pain not only for the cases but also causes severe psychological burden on the families (King et al 2005).

In recent years, effective therapy options have become available for managing it as a chronic disease, allowing close to normal life spans (Howard, 2016). The therapies are not costly and are already part of national and state guidelines for management of SCD. However, in poorer population the benefits of availability of such therapy are still not reaching those who need it (Ansung, 2013). One key bottleneck is lack of timely diagnosis due to the limited testing capacity (Hayes et al).

From 2017 onwards, the Department of Health and Family Welfare in Chhattisgarh has created capacity to carry out screening of a large number of 2-18 year old children, using Solubility Tests. Maternal screening has also been initiated. Chhattisgarh has carried out screening for sickle cell using solubility tests - Around 60 lakh screened by public system, around 6% screened positive. But confirmatory test (electrophoresis) could be completed for less than a third of the screened positive persons in Chhattisgarh. Experience in many other third world countries has been similar (Okwi et al, 2010).

A large proportion of those screened positive are unable to reach the laboratories where the confirmatory tests are available in Chhattisgarh. Capacity for electrophoresis is limited, available in District headquarters and a few CHCs, families face barriers of distance and travel-cost. HPLC testing is even more difficult as it is available only in a few tertiary hospitals. A large number of persons who have been screened positive do not know their actual status (AS or SS), but face anxiety. More importantly, the SCD cases (SS) who never get confirmed due to barrier of cost and distance, miss the opportunity to get the required therapy and counseling timely. Those who are able to access confirmatory testing incur large out of pocket expenditure.

There is a need to find ways to ensure ‘confirmation’ close to where people stay. The current project is aimed at addressing this gap – of confirmatory tests being conducted for the suspected cases, either identified clinically or through Solubility screening. Global and Indian literature recommends inexpensive Point of Care (POC) Testing for SCD in resource-poor settings (McGann, 2017). The project has relevance not just for Chhattisgarh but also nationally.

Evidence for POC for SCD: Now, adequate global scientific literature is available that has shown that POC kits are technically sound. The literature is on two types of POC kits/technologies:

1. HemotypeSC (competitive lateral flow assay incorporating monoclonal antibodies for detection of hemoglobin A, hemoglobin S, and hemoglobin C). There is enough evidence in multiple countries (summary enclosed). A multi-centre study has been carried out on this kit in India, under leadership of National Institute of Immunohaematology (an ICMR body). This study has also shown excellent results through above POC kits. This technology is already registered by Health ministries of registered in Ghana, Kenya, Nigeria and is in use in several countries.
2. SickleScan - (multiplexed qualitative point-of-care immunoassay). The technology has been found to have high specificity and sensitivity in a couple of studies. Its expected cost is around 40% higher than HemotypeSC. However, the evidence available is not comprehensive. There have been no studies in India on the soundness of this technology. None of the ICMR bodies have examined its accuracy.

There is a consensus that competitive lateral flow assay based POC kits are technically sound for SCD confirmation and are available for procurement. Their cost also seems to be affordable. However, the kits have not been used in government health system in field situations. Therefore before bringing in widespread use of POC, it will be useful to understand the best ways to implement it in the existing public health system. This requires a pilot project and operations research.

This study is aimed at health-systems aspects and the objectives are not bio-medical in nature. The study is not aimed at finding out how good the testing method is. The study is focused on finding the best ways to integrate this method with the existing public health system.

An Expert-Consultation was organized jointly by Department of Health and Family Welfare (DoHFW) Chhattigarh, State Health Resource Centre (SHRC) and Unicef Raipur office on 24th

October 2020. There was a complete consensus in the consultation that the competitive lateral flow assay based POC kits (HemotypeSC) are technically sound and DoHFW, Chhattisgarh should implement such a project. A key suggestion received from experts was that adequate effort should be put in training for ensuring correct testing. Director, Health Services Chhattisgarh expressed willingness on behalf of DoHFW to implement POC for Sickle Cell in Chhattisgarh.

### **Need of the Study**

The state is starting a pilot project based on POC testing for Sickle Cell. The aim of the study is to find out the best ways to implement POC for SCD in public healthcare system in Chhattisgarh in terms of confirming the SCD/trait in time and starting the required therapy and preventive measures. In order to introduce such intervention we will have the following questions to answer:

### **Key Research Questions**

1. Who should be tested using POC? At what level of care, POC testing should be carried out in terms of fulfilling the need and in terms of feasibility? How should POC be integrated with existing system of screening? Are there any negative consequences of using POC?
2. How should the health workforce be trained to ensure best results?
3. How to ensure that those diagnosed through POC get the required therapy?
4. What will be the costs involved in POC based detection? What are the ways to achieve desired results in reasonable cost?

### **Methodology:**

Question 1: A tentative set of target groups for POC testing was decided based on literature review and consultation with experts. For each such target group, the following aspects were assessed after implementing the pilot – How easy or difficult was it to identify the persons in the target group? Whether they were easily accessible? Whether identifying and reaching them were possible by integrating it with existing platforms or mechanisms of service-delivery? Conversely, whether the persons tested found the mechanism comfortable?

In order to assess the above, qualitative interviews of the tested persons, manpower carrying out identification and testing, clinicians, implementing administrators will be carried out. Also, the number of persons covered in screening and testing in the target group will be assessed.

Question2: Health workers at different level of care including supervisors of community health workers will be trained on POC testing. Laboratory technicians, Staff Nurses, ANM and Mitanin Trainers will be given hands on training. Videos of test procedure and written guidelines will also be shared with the health workers to enhance their testing skills. Quantitative assessment of their testing skills will be done to evaluate the desired competence.

Question3: What proportion of the SCD cases identified in pilot could be linked with medical consultation to decide the treatment? In depth aspects will be explored through Qualitative Interviews with above stakeholders.

Question4: Cost per case of SCD confirmed will be calculated for the POC based route versus those confirmed through existing methods without POC. (Structured questionnaire will be used to collect data on cost from beneficiaries and health officials). Quantitative data will be taken from reports designed for the pilot. For costing, beneficiaries will be interviewed to find out out of pocket costs and administrators will be interviewed for costs incurred by government.

**Study settings:** Since we adopted a pilot testing model, five districts were selected that represent the population profile of Chhattisgarh (one district selected from each of the five divisions of Chhattisgarh). Durg and Mahasmund have non-tribal population and three districts Dantewada, Korba and Sarguja have predominantly tribal population.

**Sample:** For Interviews with persons tested – 10, persons confirmed -10, 10 Testing Staff, 10 Clinicians, 5 implementing administrators.

For cost data, 50 beneficiaries and 5 implementing administrators will be interviewed.

**Ethical Considerations:** Informed Consent will be taken from all persons to be tested under the study. Informed Consent will also be obtained from all persons to be interviewed in the study. Ethics approval was obtained from the Institutional Ethics Committee of State Health Resource Centre, Chhattisgarh. Effort will be made to ensure the necessary healthcare for those identified as Sickle Cell Anemia cases by linking them with appropriate health facilities.

## **Results:**

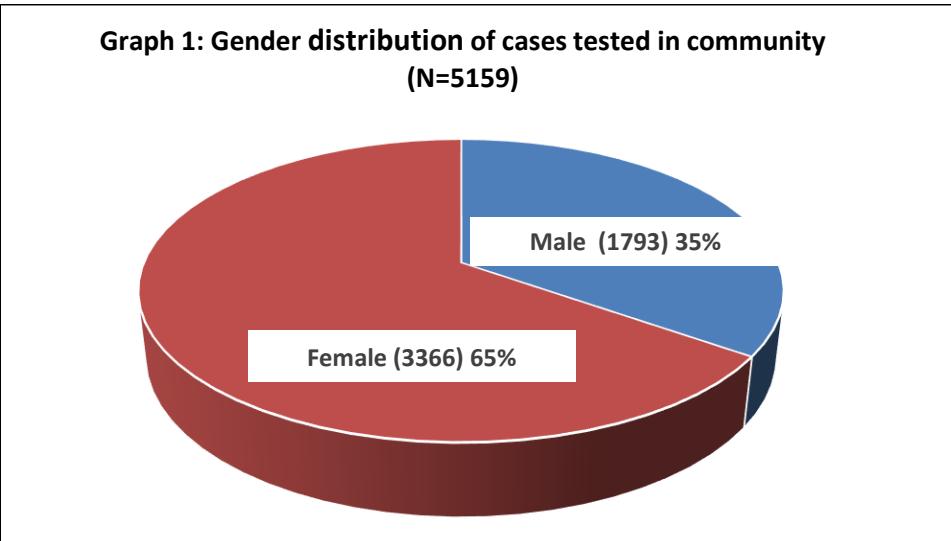
**Objective1:** Who should be tested using POC? At what level of care, POC testing should be carried out in terms of fulfilling the need and in terms of feasibility? How should POC be integrated with existing system of screening? Were there any negative consequences of using POC?

Based on the experts suggestions for testing at health facilities, it was planned to do the testing of pregnant women visiting for antenatal care, along with this it was also planned to do the testing of suspected cases identified by physicians in the OPD care. For community level testing, experts suggested testing the existing screened solubility positive cases those have not been tested for electrophoresis. To prepare the list of solubility positive cases it was planned to do the active search for screened positive cases i.e. pregnant women screened in ANC and the school children screened by RBSK teams. Suspected cases and those having sickle cell positive patients in their family were also included as target group for testing. This active search was done by Mitanin trainers with the help of Mitanins (CHW) in their respective field areas.

Due to the COVID-19 pandemic, there was a shortage of enough patients (with clinical symptoms requiring SCD testing) in health facilities. However, through mobilization of cases through CHWs. a total of 1088 patients with clinical symptoms were tested in health facilities of five pilot districts.

#### **Testing of solubility positive cases in community:**

A key approach was to test the suspected patients using POC kits identified by active case search at community. At the time of writing this report, 5159 persons were tested in 5 pilot districts and of those 65% were female (Graph 1). Majority belonged to 6 to 18 years of age group as the main target group at community was school children screened by RBSK teams (table 1). Test results were reported for 5014 cases and 6.4% were diagnosed to be sickle cell disease patients (SS).



**Table 1: Age profile of cases tested in community and their results**

Age groups	Freq.	Percent	Sickle cell diagnosis		
			AA	AS	SS
Infants up to 1 year	34	0.7	7	26	1 (2.94%)
1 to 5 years	307	6	53	222	32 (10.42%)
6 to 18 years	2865	56.03	449	2228	188 (6.56%)
above 18 years	1907	37.3	490	1311	106 (5.56%)
Total	5,113	100	999 (19.54%)	3787 (74.07)	327 (6.40)

Active search strategy of suspected cases was very effective at community level. Mitanin trainers took the list of solubility positive children from RBSK team and visited their homes and do the POC testing. Also during their home visit for active search they prepared a list of cases that have been solubility positive but not confirmed and cases with symptoms or episodes similar to sickle cell disease.

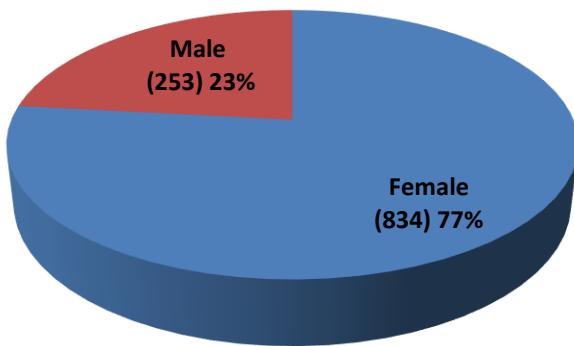
The demographic profile of the persons tested in health facilities are given in graph 2 and table 2. It shows that around three fourth of the tested were female. A majority of the persons tested in health facilities were above 18 years of age groups. Most of the adults cases tested in health facilities were pregnant women as those were the main target group for testing in facilities. Test results were reported for 1047 cases and 12.3% (129) were confirmed as SCD (SS) cases.

Sickle cell is a mandatory test in the ANC guidelines of Chhattisgarh. It was found that the pregnant women had got screened with solubility tests during ANC but their confirmatory tests were pending. They were tested with POC tests.

Earlier those were screened positive based on solubility test did not have a correct picture of their status neither confirmation or correct counseling was available. Thus solubility positive patients often had a misperception of being sickle cell disease patients and some of them landing in hands of private providers and paying high charges. While interacting with a pregnant woman was confirmed as sickle cell trait by POC kit expressed-

*“During my first ANC visit at PHC, i was tested for sickle cell and it came positive. Doctor told me that you have to go to CHC for confirmation, I went to CHC but they again did the same test and told that you have sickling problem but they did not do the confirmatory test. I and my entire family were tensed. Now after getting my correct status through this new test (POC), I am much relieved. Now I know I am not a sickle cell disease patient and only a trait.”*

**Graph 2: Gender distribution of cases tested in health facilities  
(N=1087)**



It is likely that most of the persons tested in facilities belonged to the following categories: a) blood relatives of existing SCD cases b) those screened positive in solubility testing especially ANC cases

**Table 2 Age profile of cases tested in health facilities and their results**

Age groups	Number tested	Sickle cell diagnosis		
		AA	AS	SS
Infants upto 1 year	21	10	10	1
1 to 5 years	41	16	19	6
6 to 18 years	170	52	66	52
above 18 years	815	257	488	70
Total	1,047	335 (32%)	583 (55.7%)	129 (12.3%)

### **Experience of experts/clinicians on Point of Care Testing**

Clinicians who used this POC kit under pilot project expressed no need for additional testing through electrophoresis. They also liked that the POC tests can be performed easily and results are available to the doctor quickly. It saves money of patient on traveling. This method is the best method to do sickle cell tests and identify diseases in the community.

One of the medical officers told that “*Point of care test can be used in OPD settings; it is very easy and simple technique and give results in 10 minutes. A doctor can use it even if the Lab technician is not there*”

Another medical officer told that “*Point of care test should be used where there is sickle cell belt (area with high prevalence). This test should also be used for ANC checkup so that more and more pregnant women can get confirmatory testing for sickle cell.*”

A major concern expressed by doctors was that the government should ensure regular availability of POC and the community should also know that it is now available.

Clinicians were asked about the level of care where it should be introduced in public health system and who should be tested as target group to have more feasible efforts. Their common suggestion was that POC testing should be extended up to the Sub health center and primary health center level. As per their opinion target groups should be- School children, pregnant women, adolescent girls and if they found positive their family members should also be tested.

### **Experience of laboratory technicians on using point of care test kit**

The laboratory technicians found using POC test kit as a major improvement. They felt that POC technology saves their lots of time and gives correct result. They found electrophoresis to be tedious and sometimes inaccurate. They did not find the reverse reading to be a problem. Using the chart given to them, they could easily read the test.

Their common consensus was that detection of sickle cell disease through the Point of care test method has become easy, as compared to the electrophoresis method. One of the lab technician reported that:

*“Earlier we were using an electrophoresis method that takes time and procedure is in many steps also, patients do not get results on the same day. Now using this POC kit we can get the correct result within 10 minutes and patients get the report same day.”*

#### **Experience of Mitanin trainers and Mitanins (CHWs) on POC kit testing at community level**

Mitanin trainers were sending the SS patient to CHC/DH for further consultation with doctor so that their medication could start. Mitanin Trainer was also counseling the tested individuals and their families as per the test results. There was difficulty in searching a few of the children given in Chirayu list as father/mother name was not mentioned in the list. For suspected cases, the potential candidates for testing as per Mitanin trainer were person having acute pain in joints, those in need of blood transfusion, having a confirmed AS or SS family member.

Mitanin trainers and mitanins found POC very useful as it gives the confirmation results within 10 minutes and the procedure is also very simple. In the earlier method, patients had to visit CHC or DH. Sometimes even after going there, they could not get the confirmed results. Some of them visited private facilities and spent a lot of money.

One of the Mitanin Trainer shared her experience and told that-

*“Earlier patient has to spend around Rs. 500 to 1000 for transportation, food, screening and including one day wage for visiting a health facility for diagnosis of sickle cell. Beforehand, family had to do multiple visits to hospitals for testing, getting report, medicine and for consultation. But now having POC kit has cut down the out-of-pocket expenditure on testing.”*

They did not find the reverse reading to be a problem. Using the chart given to them during their training on POC, they could easily read the test. To cross check the reading by Mitanin trainers, those found SS by them were tested again in the health facility by lab technicians.

#### **Were there any negative consequences of using POC?**

In terms of testing and diagnosis of there were not any negative consequences observed in the pilot. In pilot districts, the POC kit found high acceptability both among the healthworkers and the patients. One concern was related to the supply and availability of POC kits.

#### **How should POC be integrated with existing system of screening?**

In pilot project feasibility of testing was done at community as well as health facility level. The purpose behind this was to assess the feasibility of POC testing in both the settings if integrated with existing system. The testing results and experiences and feedbacks of clinicians, Lab technicians and Mitanin Trainers (MTs) shows that this POC kit can be very easily rolled out in the existing health system of the state.

### **Question 2: How should the health workforce be trained to ensure best results?**

Training of health workers on POC testing kit was given a lot of importance from the beginning of the pilot project. Consultation with experts was done to finalize the training strategy of health workers. For training of master trainers and finalizing the training material advice was sought from experts of National Institute of Immunohaematology, Mumbai (an ICMR body). To ensure the best results the kits were also shown to experts at AIIMS, Raipur.

First it was planned to do the hands on practical training of laboratory technicians on POC testing. Trained master trainers went to each districts and conducted hands on training of LTs in their respective districts. Pre and post test was also taken to assess their learning. Training guideline was developed in Hindi including step wise pictorials with instructions. A video film with standard testing procedure was also prepared on POC testing and was shown to the LTs and was given in their mobile phones.

Total 56 laboratory technicians from each district were trained from 5 pilot districts along with one pathologist from each district. After training their post test average score was 94%. All the LTs were given hands on exercise to conduct the testing during training. In POC testing the important part was the reading of the test results i.e. getting used to inverse reading. The colored charts depicting all the scenarios of test results were given to LTs for cross checking of the test results.

After the pilot, one LT from each CHC and district hospital from all districts of state were trained on POC testing on similar pattern at Raipur medical college.

The training of Mitanin trainers was carefully supervised. First the state level master trainers trained the block level health workers. Under the supervision of master trainers these block level health workers conducted training of Mitanin trainers in small batches. They were also given the training guideline in Hindi including step wise pictorials with instructions along with a video.

From rural areas, 163 Mitanin trainers and in urban areas 60 Mitanin trainers were given training on POC testing. Their average post test score was 87%. After training hand holding support by

block health workers and master trainers was provided and in case of any confusion on testing their query were immediate taken care and resolved. For quality control on testing Mitanin trainers were instructed to send the test result picture of each case to the Master trainers for validation of their results.

A batch of doctors from the pilot districts were given training on use of POC test kit and management of SCD patients by clinical experts from AIIMS Raipur.

**Question 3: How to ensure that those diagnosed through POC get the required clinical management (therapy) ?**

Individuals tested as SCD (SS) using POC, were referred to the doctors at CHCs and DHs. Mitanin trainers and Mitanin CHWs played an active role in this follow-up. The follow up and treatment data was also collected in a structured format.

Of 327 diagnosed SCD cases at community level, data was collected on 277 SS cases from Durg, Mahasamund, and Korba districts. Out of them, 75.36% visited health facilities. Of those who visited health facility, 65.07% were reported that Hydroxy urea was prescribed to them.

**Table no. 3 Treatment and follow-up of confirmed cases**

<b>Characteristic's</b>	<b>Response</b>	<b>Frequency</b>	<b>Percentage</b>
Visited Health Facility (N=277)	Yes	209	75.36
	No	68	24.64
Re-test done through POC/Electrophoresis (N=200)	Yes	117	58.5
	No	83	41.5
Medicine Prescribed (Hydroxyurea) (N=209)	Yes	136	65.07
	No	73	34.93

Early diagnosis and initiation of treatment work as a secondary prevention in disease like sickle cell. Testing of family members of SS and AS individuals was conducted and found to be useful in detecting further cases. For other suspected cases and their siblings, the screening can be conducted at community level as well as facilities.

As this test kit also has high yield on diagnosis of newborn, newborns can also be screened at the site of institutional delivery in cases where the mother was found AS/SS during ANC. In case of home deliveries, it would be performed during first vaccination. POC will enable confirmation of SS at newborn stage. This will help in making intervention at early stage - Pneumococcal vaccination (PCV 13 vaccines can be provided to all the children who have been diagnosed with sickle cell anemia. For Infants (6 weeks to 6 months of age) 0.5 ml injection is administered at 2,

4, 6, and 12 to 15 months of age for 4 total doses. ( on the same timings as DPT vaccines). This would contribute significantly to reduction of under 5 mortality due to respiratory infections (currently the most common cause of under 5 mortality).

Timely detection through POC can help in timely initiation of oral penicillin prophylaxis.

Daily folic acid supplementation can be provided to all the patients with sickle cell disease. For the children below 3 years of age, we can provide the same in syrup form.

Along with children it was also very important to screen adolescent girls for the sickle cell anemia. However primary prevention can be assured if those adolescents with sickle cell trait are detected and encouraged from inter-marrying. In essence it is a process of improving the genetic pool in communities with high degree of consanguinity. The argument seems persuasive in a community where arranged marriages within the community are the norm. But there is no evidence that counseling, however comprehensive, will be remembered throughout the individual's reproductive life, influence partner selection, alter use of prenatal testing, or ultimately reduce the rate of births of affected children.

Sickle cell screening programs in the past have failed to adequately educate patients and the public about the significant differences between sickle cell trait and sickle cell disease. This has resulted in unnecessary anxiety for carriers and inappropriate labelling by insurers and employers.

**Question 5: What will be the costs involved in POC based detection? What are the ways to achieve desired results in reasonable cost?**

Cost per case of SCD and SC trait confirmed was calculated for the POC based route versus those confirmed through existing electrophoresis based route.

**Methodology:** Cost per case of SCD and SC trait confirmed was calculated for the POC based route versus those confirmed through existing methods without POC. A structured questionnaire was used to collect data on cost from beneficiaries and health care staffs. For unit cost of solubility test kit and electrophoresis reagents current government rate contracts were taken. The equipment and other consumable cost were also taken by interview of laboratory technicians and were factored in for per test cost. HR cost was calculated using data on their salary and average time given by them in conducting one test. 50 beneficiaries were interviewed for the wage loss, travel cost and any other expenses during their visits to health facility.

**1. Existing mechanism for sickle cell diagnosis:** In state the current sickle cell screening guidelines suggest the screening of pregnant mothers using solubility test during antenatal care (ANC) and if they found screen positive then they were sent to CHC/DH for confirmation using electrophoresis test. For those who are solubility positive their husbands/family members are also

screened using the same mechanism. Along with this school children are also screened by mobile teams of RBSK (Chirayu) using solubility test and referring them for further electrophoresis for confirmation.

#### **Cost points for patients under existing mechanism of screening and diagnosis:**

1. **Travel cost:** In current situations electrophoresis is mostly conducted at district hospitals. Therefore patients have to travel on their way from village to district hospitals and they have to visit twice. First day they go to district hospitals and give their blood sample and second day have to again go to collect their reports. In most of the cases particularly in pregnant lady they go along with their family members. We have collected data on travel cost of the patients.
2. **Wage loss:** On their visits to district hospitals most of the patients reported loss of their wage for two days.
3. **Payments made at hospitals:** Patients reported that during their visit to district hospital first they pay 10 Rs for the OPD registration and many times (except pregnant lady) they have to pay user fee for electrophoresis tests.

#### **Cost points for government under existing screening and diagnosis mechanism:**

1. **Cost of solubility test:** This was based on CGMSC rate contract.
2. **Cost of electrophoresis test:** This was based on CGMSC rate contract.
3. **Equipment and other consumable cost:** The cost for electrophoresis machine and other consumable charge the total cost per test was calculated.
4. **Human resource cost for solubility and electrophoresis tests:** The average HR cost for conducting both the tests was calculated.

#### **2. Cost points for patients diagnosed using POC test kit:**

1. **Travel cost:** The POC tests kit was made available at community level, (testing though Mitanin trainers), at urban PHCs, CHCs and district hospitals. Most of patients were tested at community level and some were also tested at health facility level. Those who were tested at community level did not spend any money on traveling. Whereas those tested at health facilities has traveled from their home to health facility. As it give confirmatory result by single test and it gives the result within 10 minutes patient does not have visit twice.
2. **Wage loss:** Patient those were tested at community did not loss their wages but those who traveled to the nearest health facility for testing loss their half day/full day wages.
3. **Payments made at hospitals:** Patients reported the average payment that patients made at hospital.

#### **Cost points for government using POC testing kit:**

- Cost of solubility test:** It was planned to do POC test for the patients who have been earlier screened using solubility tests. The earlier CGMSC rate contract was used.
- Cost of POC test kit:** The cost per test kit was 150 Rs.
- Human resource cost for solubility and POC test:** The average HR cost for conducting both the tests is around 28 Rs.

#### **Overall cost using existing diagnosis mechanism and using POC test kit at health facility and Community level**

<b>Existing mechanism</b>	<b>Amount in Rs.</b>
Total cost using existing mechanism	844
Total cost using POC test kit at facility level	536.5
Total cost using POC kit at community level	175.5

#### **Overall comparison of cost for screening and diagnosis of per sickle cell disease patients:-**

In this analysis we have taken three assumptions i.e. 1) Screening using solubility and confirmatory by electrophoresis at health facility level. 2) Screening using solubility and confirmatory using POC test kit at health facility level. 3) Screening using solubility and confirmatory using POC test kit at community level.

Screening is done by solubility methods by ANMs/ Mitanin trainers/ LT at PHC and the cost for all the three assumptions is similar as per the above mentioned costing units. Similarly cost for per confirmatory test using the above three assumption was calculated. For cases diagnosed at community level needs to visit once to the health facility and for validity of the result laboratory technician can again repeat the testing using POC test kit. The screening cost per SS case was Rs.4554. The confirmation cost varied from Rs.7213 to Rs.16168 depending upon the model - POC test kit at community and for SS case repeat test at health facility or Electrophoresis at health facility

The cost analysis shows that diagnosis of SCD patients using POC test kit at community level and later confirmation of SS cases by repeating the same test at facility level is 55% less costly than the existing mechanism of confirmatory though electrophoresis at facility level.

Similarly diagnosis of SCD patients using POC test kit at facility level is 27% less costly than the existing mechanism of confirmatory though electrophoresis at facility level.

## **Recommendations:**

1. Pilot results on POC test kit shows that it screening of SCD patients is feasible at health facility as well as community level. Therefore it should be scaled up across the states.
2. a) At community level the target groups would be- a) suspected cases (with symptoms or history of crisis or blood transfusions) identified through active search b) solubility positive pregnant women screened in antenatal checkups and c) solubility positive school children screened by RBSK team d) family members of all AS/SS confirmed individuals  
b) At health facility level the target groups would be- solubility positive pregnant mothers visiting health facility for their antenatal checkups, clinically identified OPD patients with relevant symptoms, newborns born to AS/SS mothers/couples.  
Along with patients diagnosed as SCD using POC test kit at community level can be tested again at health facility before initiation of treatment.
3. Role of Mitanin and Mitanin Trainers- Active search of suspected cases, testing of active search cases, testing of backlog of solubility positive children in RBSK screening. They will counsel families on implications of being AS or SS. They will also follow up the SS cases for sending to facility for initiation of treatment and counseling for adherence to treatment.

**Role of Clinicians:** identify clinically suspect cases and ensure their testing using POC test kit and based on assessment of their symptoms initiate treatment.

3. POC test kit should be included in the essential diagnostic/consumables list of state. It should be indented regularly and its supply should be ensured so that testing and treatment of patients can go hand on hand.
4. Before providing POC kit in the field, training of health workers and lab technicians should be done. Periodic training of clinicians should also be done on SCD management.
5. A state and district level data base of SCD positive patients should be kept along with the status of how many are on treatment. Patient should be followed up by the community health workers for their treatment and adherence.
6. Newborns and children tested as SS should be provided the available prophylaxis i.e. pneumococcal vaccine and Penicillin V.
7. The major route for SCD screening should be using POC test kit at community level. This would be more cost effective and help the people in remote and rural areas in getting confirmatory tests.

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