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Improving Healthcare Coordination in the Mandi District

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WPI

Improving Healthcare Coordination in the Mandi District

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Abstract

Rural healthcare workers in the Mandi District face unique challenges in providing quality care due to mountainous terrain and lack of supplies. This project evaluated the existing system of communication between health centers and identified areas in which the system could be improved to mitigate the effects of these challenges. We recommended a new system for medical stock requests and deliveries which could decrease delays by up to fifteen days and ultimately improve the quality of care for patients.

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Authorship Page

Gopal Aggarwal contributed to the conduction of interviews; the translation and analysis of interviews; and the design and development of the Visual Stock Indicator System.

Edward Dring contributed to the writing and editing of each section of the report; the analysis of the interviews; the design and development of the Visual Stock Indicator System; and the design of the poster.

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Jacob Maalouf contributed to the writing and editing of each section of the report; the analysis of the interviews; the design and development of the Visual Stock Indicator System; and the design of the poster.

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Project Report

Enhancing Communication in the Mandi District Health System

Rural communities around the world characteristically struggle to administer healthcare that matches the standards set in urbanized areas due to a lack of resources, in terms of both personnel and procedural capabilities. These challenges tend to be explained by limited funding, geographic inaccessibility, and the complexity of disease patterns (see Figure 1). The Mandi District in Himachal Pradesh of Northern India experiences all of the challenges of rural healthcare, exacerbated by the mountainous terrain and uneven connectivity in the state.

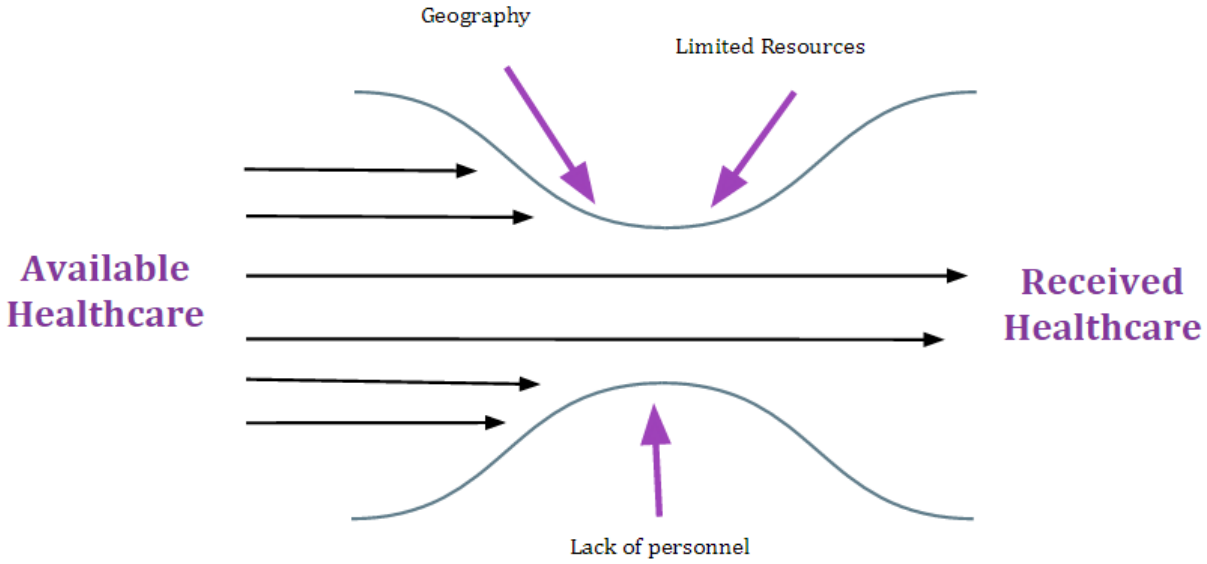


Figure 1. Healthcare bottlenecks in Mandi District (adapted from Gauba, et al., 2015).

The goal of our project was to support the development of new communication systems for facilitating coordination between health centers in the Katuala block. In this way, patient records and medical supply inventories could be better maintained and better transferred between different tiers of the public healthcare system in the Mandi District. This would cut down on wait times and the need to repeat procedures, as well as optimizing the availability of medical stock.

To achieve our goal, we completed three objectives. First, we examined stakeholder needs and technical capacity, including critical gaps in the existing network. This helped us understand the baseline communication system that each center had. Second, we identified and ranked possible communication solutions in terms of cost, feasibility, and effectiveness. Lastly, we developed and tested a proof of concept software solution to be implemented in the healthcare system, and generated recommendations for further improvement of communication in healthcare.

Challenges in Rural Healthcare

There are multiple documented discrepancies between urban and rural areas with regard to healthcare administration. In 2015, a team of students from the Indian Institute of Technology in Mandi and Worcester Polytechnic Institute assessed the primary obstacles to healthcare in the Mandi District (Gauba et al., 2015). The team assessed multiple healthcare facilities, including the Zonal Hospital Mandi and an extensive network containing multiple sub-centers within the medical block of Kataula, which was ultimately mapped.

Figure 2. Picture showing the remote location of the Balmand sub-center (Gauba, et al., 2015).

By developing and implementing a Rural Healthcare Assessment Model, the Gauba et al. project team identified three critical bottlenecks to healthcare administration in the region. The first bottleneck was inhibited physical access to facilities due to challenging mountainous terrain coupled with poor road quality, an example of which can be seen in Figure 2. The second bottleneck was related to limited supplies and medication due to sporadic delivery schedules and poor access, leading to high delivery costs. The third bottleneck was limited access to well-trained specialists, especially at the smaller, understaffed sub-centers. These bottlenecks could be overcome through increased coordination, such as improved communication, organization, and healthcare portability solutions.

Partially due to bottlenecks that restrict rural healthcare, serious discrepancies exist in the quality of healthcare between rural and urban areas. For example, in the case of road accidents, the higher death rate in rural areas such as Himachal is a function of "lack of first aid, delays in transfer of patients, longer time interval between injury and reaching a definitive hospital, absence of triage, [and a] lack of facilities in hospitals" (Gururaj, 2008). Similarly, 85% of preventable deaths due to diseases such as diarrhea and pneumonia occur in rural areas, suggesting that "the majority of care for these children, if any, was provided locally and likely by those lacking comprehensive health training" (Morris et al., 2011). These findings highlight the need for more efficient communication systems which could better manage inventories of antibiotics and other supplies, or could facilitate the transfer of patients between hospitals.

There are a variety of key stakeholders invested in the implementation of an improved health coordination system within the Kamand and Mandi region. The most invested are healthcare providers, including officials such as the Chief of Medicine, doctors, and clinic staff. Healthcare staff face challenges maintaining inventories of supplies, storing patients' histories, and transferring patient information between healthcare tiers. Patients are also important stakeholders, as coordination can have direct impacts on their quality of care. There are often long waits at health centers because staff must collect the same

information at each visit due to lack of communication, which leads to wasted time and possible endangerment of patient health.

A 2008 case study in rural South Africa found that rural clinics often struggle to maintain, transfer, and use patient information (Garrib et. al., 2008). The researchers analyzed quality of the data entered into a newly implemented District Health Information System in ten different healthcare facilities. The results indicated a high perceived work burden of data collection and entering. There was frequently missing data and little explanations for abnormal data values, along with limited use of the data. If a system is not intuitive, its users will not use the program features they do not know or care to use. These findings helped us design a system that is not only user friendly, but useful to different healthcare administration levels in rural areas of Himachal Pradesh.

A 2011 case study in Himachal Pradesh compared and contrasted two different methods of developing a Health Information System, or HIS (Oygard & Valland, 2011). Open source software (OSS) development involves multiple companies and individuals collaborating to build constantly evolving free software, allowing developers to modify the code of existing, freely available infrastructure to aid implementation within specific settings. Its main limitation is that, in some cases, a HIS may have to be designed from scratch to adapt to an especially unique setting (Oygard & Valland, 2011). The second method outlined is known as Agile Software Development, which places high emphasis upon lightweight development methods, flexibility and rapid response to changing environments. Personal communication and constant contact with stakeholders is also a major part of Agile philosophy. These characteristics are highly desirable with regards to HIS development, as the needs of medical facilities change constantly (Oygard & Valland, 2011). The comparative information outlined in this case study helped guide our choice of software development methodology in the later stages of our project.

Methodology: Understanding Existing Infrastructure

In order to support the development of a new software for facilitating communication between healthcare providers, we achieved the three objectives shown in Table 1.

Table 1. Objectives and associated strategies.

Objectives	Methods
Determine stakeholder needs and technical capacity, including critical gaps in the existing network	• Site assessment • Semi-standardized interviews
Identify and rank communication solutions in terms of cost, feasibility and effectiveness	• Feasibility analysis • Solution selection
Develop and test a proof of concept for a communication solution in the healthcare system	• Software development • Feedback collection

We started our interviews with informal visits to the clinic on the IIT campus and the Zonal Hospital Mandi to gather basic contact information for the health centers, as well as general information about the health system and need for improved communication. Post-interview translation of voice recordings into English transcripts was first used, but then simultaneous translation was adopted to include all team members in the interview. We then conducted interviews with doctors and staff at health centers from four tiers (sub-centers, primary health centers, community health centers, and zonal hospitals) to assess their

Figure 3. Map showing healthcare infrastructure of the Katuala block in the Mandi District.

technical capacities, perceptions of communication problems, and thoughts on possible solutions. Our primary focus was on the Kataula medical block (shown in Figure 3) which includes the Zonal Hospital Mandi, the Kataula Community Health Center, and seven sub-centers located in the villages of Tandu, Taryambli, Riyagri, Kamand, Tihri, Namlay, and Balmand. We also conducted interviews at the Padhar Community Health Center and the Phali Primary Health Center to assess how representative communication within the Kataula block is of other medical blocks in the Mandi District. Together, these eleven chosen health

centers gave us a good representation of the different interactions between the four tiers. A picture of our team conducting interviews can be seen in Figure 4.

Figure 4. Conducting interviews in Neri.

The results of the interviews were used to determine sub-center technical capacity, allowing us to conduct a feasibility analysis of possible communications systems based on what the existing infrastructure could support. Aspects of the existing systems were also analyzed in order to determine the area with the greatest need for improvement. Using this information, an appropriate communication system was selected. System requirements and design, as well as all necessary materials, were compiled in a single document to facilitate the development process. After development of a prototype, the system was introduced to the District Program Officer at the Zonal Hospital Mandi to obtain feedback about the system and suggestions for improvements. Final recommendations were compiled for the development of future government programs related to healthcare communication.

Results

Completing interviews at the eleven health center locations helped our team determine what needs and capacities the stakeholders have. We also learned about the flow of information and supplies between the four healthcare tiers.

Healthcare Infrastructure in the Mandi District

Sub-centers are the smallest unit of the healthcare hierarchy and the first point of contact with the system for most of the community, followed by larger primary and community health centers, all of which are overseen by the main zonal hospital. Each of the seven sub-centers within the Kataula medical block serves a population ranging from 800 to over 3,000 residents. They are each staffed by a male and a female health worker. In the Mandi District as a whole, there are 311 sub-centers, served by 61 primary health centers, 13 community health centers, and 6 hospitals.

Patient Care in Sub-Centers

Health centers fall under two main categories, preventative and curative. Through interviewing health workers in the Mandi District, our team discovered that basic sub-centers only provide preventative care, with limited first aid capabilities. As stated by the District Programs Officer, Mrs. Anuradha Sharma, “The sub-centers are basically focused on preventative… they look after programs like immunization, family planning, tuberculosis

and malaria eradication, and other vector borne diseases." For curative care, patients must go to the higher level health centers like the Kataula Community Health Center (CHC) and the Zonal Hospital Mandi (ZH).

Out of the seven sub-centers where interviews were conducted, none of the health workers at any location said that referral slips were used. On average, only one patient per month is referred to a higher health center. This referral process is either done through calling the higher level center to warn that a patient is coming or not communicated at all. Most patients understand that the sub-centers are unable to provide curative care and travel to a larger health center without first stopping at the lowest level.

Medical Stock Information

Sub-centers maintain stocks of simple medicines and supplies to attend to preventative needs and minor ailments. These supplies include mild painkillers, vitamins, cold medications, TB immunizations, and first aid supplies such as wound cleaners and dressing. The sub-centers are supplied with medical stock from higher ranked medical centers, flowing from the ZH to the CHC before continuing to the sub-centers as shown in Figure 5 below.

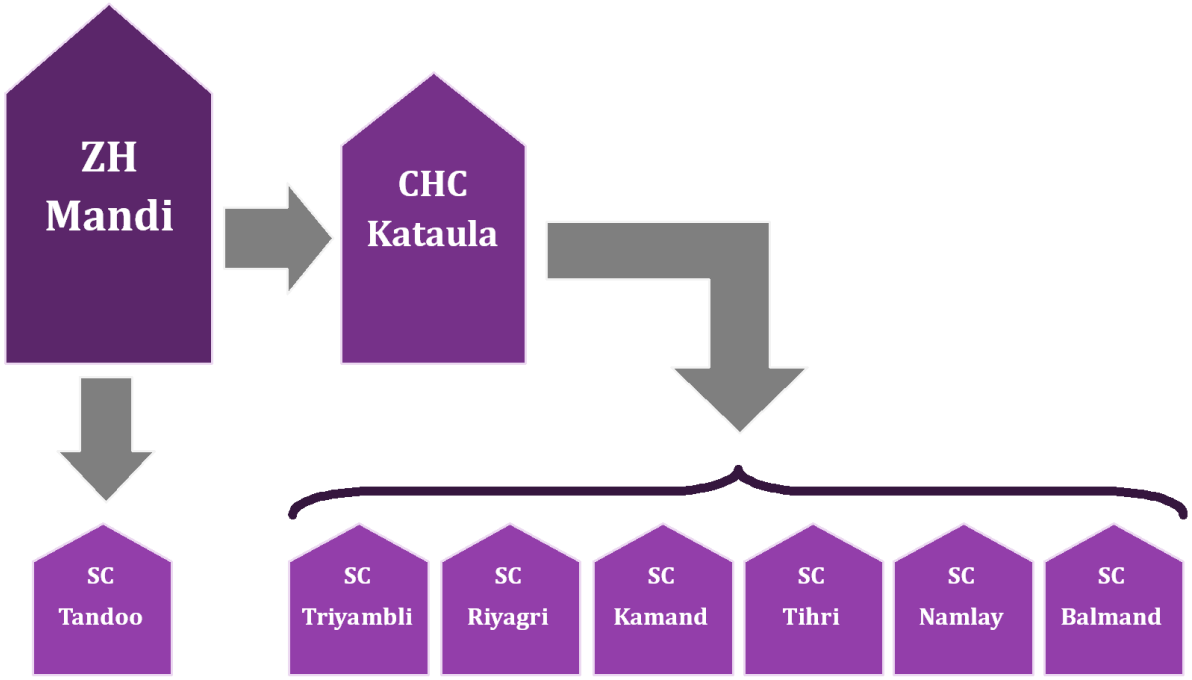


Figure 5. Coordination chart representing the flow of medical stock in the Katuala block.

Six out of the seven sub-centers interviewed reported that they receive stock from the Kataula CHC, the exception being Tandu, where stock is received directly from the ZH due to its close proximity (see Figure 5). The process of restocking begins in a monthly meeting in which workers from all seven sub-centers travel to their higher-tier center and request necessary stock as recorded in a handwritten stock register. This requirement of a

scheduled in-person meeting sometimes causes delays of up to 15 days between an apparent need in a sub-center and the notification of a higher-tier center.

All sub-centers also reported frequent delays in restocking between 5 and 14 days after this monthly meeting. However, none of the sub-centers reported that stock shortages happened because of delays from the CHC; one sub-center worked indicated the issue was with back-end supply, saying that "...[the CHCs] have a storage problem, so they try to get the stock out as soon as they can…[but] it could happen that there is a delay from the ZH to the CHC." This was confirmed by a health worker staffing a different sub-center, who reported that "...many times supply does not come. But if the ZH has stock, then we are supplied immediately." Interviews at the CHC Kataula revealed that they have a vehicle which is used to pick up supplies from the ZH. Another sub-center worker indicated that delays could be reduced if stock was supplied directly from the ZH rather than having the CHC as a middleman, because occasionally she cannot attend the monthly restocking meeting to avoid the sub-center being unstaffed.

Financial & Technical Capacity

Each sub-center has a bank account and is supplied with an annual maintenance grant of Rs 10,000 every two years. This grant can be utilized for general sub-center maintenance such as purchasing chairs or equipment. Medical stock is paid for by the Zonal Hospital in most cases. If there is an urgent need and stock has yet to be resupplied, the sub-centers also receive an untied fund to buy medical supplies from government authorized stores.

The technical capacities of the sub-centers were recorded and are shown in Figure 6. Each sub-center health worker is supplied by the government with a basic Nokia C1-01 cell phone, capable of talk and text. Each month, each health worker is supplied with a Rs 50 recharge for this mobile device. One of the health workers, however, said that he uses his own money to recharge this phone because it is a tedious process to obtain the recharge money and Rs 50 is not enough to make it through each month. All seven of the sub-centers have cellular service for voice calling and text, but the most remote sub-centers sometimes have difficulty connecting well. Because the sub-centers do not have reliable access to the internet, they are not supplied with smartphones, tablets, or

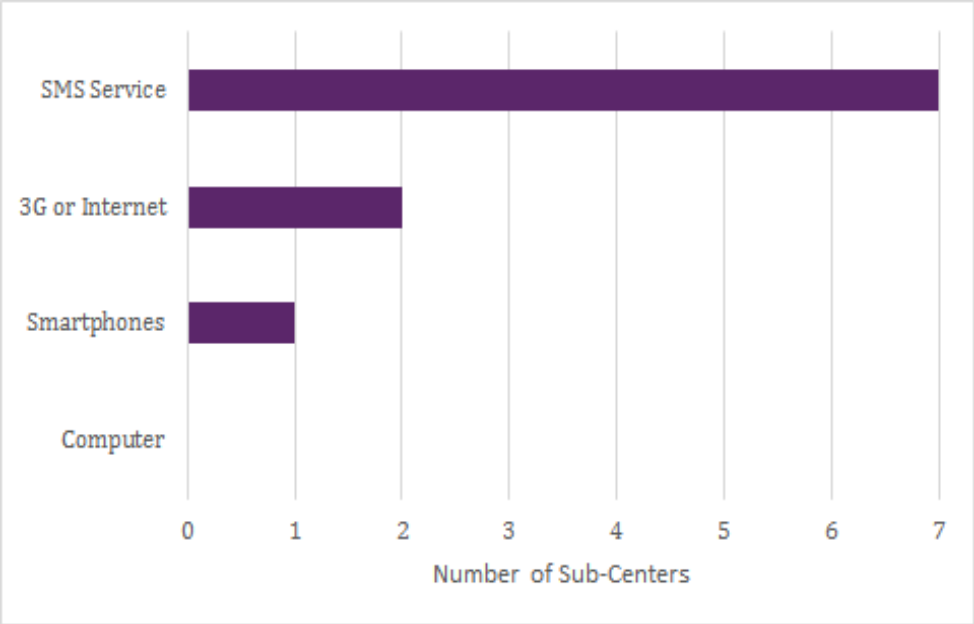


Figure 6. Number of sub-centers with various kinds of technical capacity.

computers. Even if internet access and computers were present, the sub-centers often have power outages of 1-5 hours per week; these outages being worse during the summer months and very frequent during storms.

Discussion

The results of the interviews conducted revealed trends in health worker perceptions and connectivity issues of the current system.

Health Worker Perceptions

Sub-center health workers indicated that a system to forward patient records to higher tiered health centers would not be necessary because patients usually know they should go directly to the Kataula CHC or Mandi Zonal Hospital if they have an ailment that is serious enough to require testing. Although most sub-center staff showed no appreciable need for a patient record-keeping system, they did indicate more of an issue with regards to medical stock. Currently, monthly stock registers like those shown in Figure 7 are used, and the lack of electronic communication can cause delays in notification of stock exhaustion, preventing sub-centers from providing adequate care. Six of the seven sub-centers interviewed believed that improvements to the restocking system would be a positive change. From this trend, we focused our project on increasing communication and coordination surrounding medical stock between tiers.

Figure 7. Stock register book currently used in sub-centers.

Connectivity and Technology

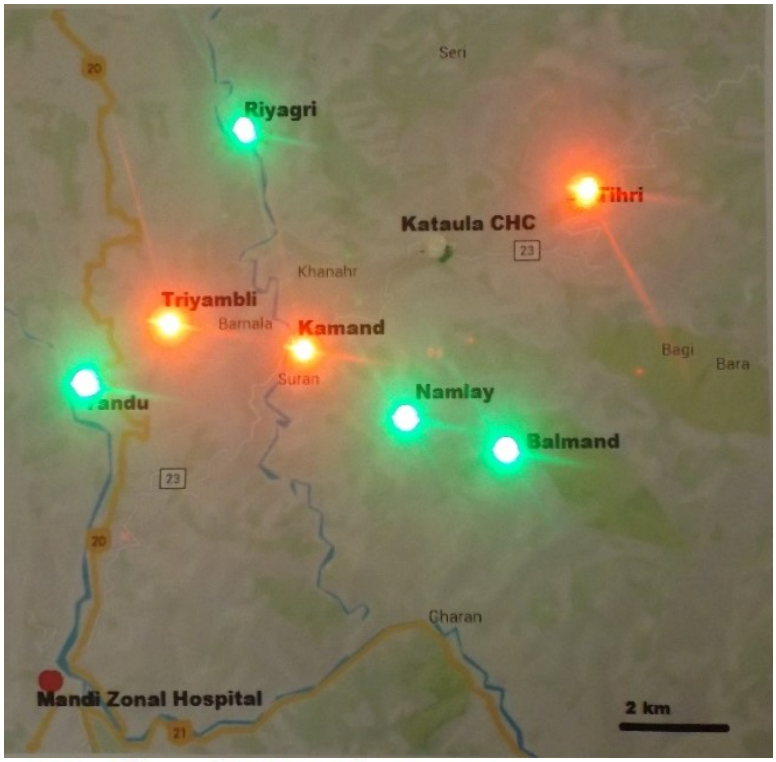
Due to major connectivity issues and lacking technology, the range of solutions that can be implemented are severely limited. If better technical infrastructure was available to sub-centers, the feasibility of self-entry of data online would be higher. However, due to poor cellular data connectivity, an online data system might still fail. From utilizing our own phones as a measurement, only two of the seven sub-centers had a cellular network strong enough to support 3G or higher data browsing. The overall trend seen in the sub-centers is that implementing smartphones, tablets, or computers is not feasible, although government involvement in the coming years may increase their capacity to do so.

Project Outcomes

Our findings indicated that insufficiencies in the communication system between health centers create a burden for health workers, ultimately detracting from the quality of patient care. To address these issues, we developed a number of recommendations for the government and the District Program Officer that will streamline the process of restocking medical supplies. These recommendations are based around the adoption of a system we developed to reduce delays in notifying the Zonal Hospital of stock needs, coupled with future improvements to the system.

Visual Stock Indicator System

To decrease the delay in restocking medical supplies to sub-centers, we propose the adoption of a Visual Stock Indicator System (VSIS). Such a system would allow workers at sub-centers to convey their need for medical supplies via a text message sent to a server at the Zonal Hospital Mandi, which operates effectively on the existing telecommunications network with the workers' government-provided phones. These messages would be received by the system and translated into LED indications on a map located at the Zonal Hospital and CHCs. In the initial prototype, green is a normal indication. Red indicates an unanswered stock shortage and request, and yellow indicates that the order is available at the CHC. When the status of a sub-center is changed to yellow, an automated SMS will be sent to update the sub-center worker. Specific details about the stock request would be visible on a website based interface, which would be open on the pharmacist's computer. Workers at the Zonal Hospital would then be able to purchase medical supplies if necessary and notify the sub-centers directly when their stock is available for pick-up. A working prototype of the VSIS system received positive feedback from stakeholders from each tier of the



Medical Stock Data

Health Center wise stock status is shown below:

Health Center	Stock Availability	Required stock	Stock Request time
Kamand	Stock Required	paracetamol	Sun Apr 24 2016
Triyambli	Stock Required	acetaminophen	Sun Apr 24 2016
Tihri	Stock Required	cetirizine	Sun Apr 24 2016
Navlay	Stock OK	NA	Sat Apr 23 2016
Balmand	Stock OK	NA	Sat Apr 23 2016

Figure 8. VSIS prototype indicating stock outages at Tihri, Triyambli, and Kamand sub-centers as well as the readout of medical stock needs. .

healthcare system, and can be seen in Figure 8.

The implementation of a VSIS would confer several benefits to the medical stock resupply system. Primarily, it would eliminate delays caused by the current process of notifying that stock is running out, as sub-centers would be able to immediately communicate their need instead of waiting for a monthly meeting to do so. It would also allow sub-centers to contact the Zonal Hospital directly, removing the delay caused by communication from the CHC to the Zonal Hospital. These two improvements could prevent delays of 15 days between the realization of the need for more supplies and the notification of the Zonal Hospital, and could eliminate the need for a sub-center worker to spend a day travelling to report stock needs. The benefits of this system would come at no additional cost to sub-centers, as they already have government-provided cell phones. The cost of initial implementation at the Zonal Hospital and Kataula CHC would be roughly Rs 3843 each (about $57 - see Table 2). Costs to maintain the system once installed would be minimal. The physical component that would be most likely to fail are the LED indicators and wires, which would not be expensive to replace if they failed.

Table 2. Estimated total cost of implementation for a VSIS.

Part Description	Estimated Cost (Rs)
2 AC/DC Power Adapters	340
30 Wires	90
8 Multicolored LED Bulbs	48
Map and Box	65
GSM Module	800
Raspberry Pi	2500
Estimated Total	**3843**

We evaluated the possibility of more simplistic and direct means of communicating stock needs, such as direct texting or phone calls to personnel at the ZH. The light-board would serve as a more persistent reminder to ZH personnel, as the LED would remain illuminated until action is taken, whereas simple texting is a one-time notification and easy to forget. The system also presents the information in a more standardized and organized fashion. Given the doubling of 3G usage in India from 2014 to 2015 (Nokia, 2015), it is likely that 3G cellular data will soon become available at sub-centers not presently covered. This would allow for expansion of the light-board system to a digitized smartphone or tablet system. Our SMS-based system would therefore serve as an initial phase in improving stock communication, allowing the health centers and workers to develop organizational practices based on direct messaging. A mobile app format would ultimately serve as a more user-friendly, long-term solution, capable of providing a greater degree of two-way communication once there is sufficient cellular infrastructure to support it. Once consistent 3G coverage is available, it would be a simple transition to have a 3G based

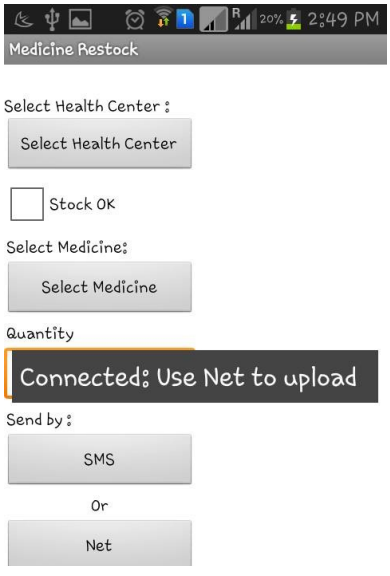


Figure 9. Android app interface for VSIS.

mobile app send stock requests to the already implemented hardware. To demonstrate this possibility, we also developed an Android app, shown in Figure 9, which allows the same stock need information to be sent more easily, either through an SMS or over a Wi-Fi connection.

Additional Policy Recommendations

In addition to the implementation of VSIS, we recommend adaptations to the current system of stock flow in the Kataula block. Upon implementation of VSIS, stock requests should go directly to the ZH rather than to the CHC. This will ensure that requests arrive at the ZH as early as possible, allowing them to order back stock in a timely manner if it is not available and reducing common delays associated with the ZH lacking supplies.

Once the ZH orders back-stock (as required) and sets aside the order, the CHC should send a vehicle to pick up the stock, which will then be appropriately distributed. If a sub-center urgently needs supplies, the CHC should deliver stock directly to the sub-center; otherwise, the orders can be set aside to be picked up by the sub-center health worker at their monthly meetings. It is possible that a stock-out light illuminated for a long period of time will lose relevance to the pharmacist in charge. In order to alleviate the risk of overlooked requests, future features of the system could include an automated series of text reminders to the pharmacist after two weeks.

Conclusion

Our interviews with health care workers in the Mandi District revealed several areas of possible improvement in the communication systems between health centers that are currently in place. These shortcomings include the need for manual transmission of statistical data from sub-centers to higher tiers of healthcare and delays in the restocking of medical supplies. Based on the technical capacity of these sub-centers as determined by our interviews, we found that improvements in the stock resupply system would be the most feasible solution, and these improvements were also perceived to be the most useful by health workers. Therefore, we designed a Visual Stock Indicator System for use in the Mandi District.

The VSIS will allow sub-center health workers to immediately notify the Zonal Hospital when they are in need of medical supplies, reducing delays in restocking and monthly closures of health centers for travel. We also proposed streamlining the process of filling stock orders by eliminating the CHC as a middleman, and by providing a pharmacist at the ZH specifically dedicated to responding to requests coming through the VSIS. Together, these recommendations will facilitate the communication between different health centers in the Mandi District, improving the availability and quality of healthcare for its residents.

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Supplemental Materials

Questionnaires

Semi-Standardized Interview Questions for Sub-Centers

- Introduce ourselves.
- Explain our project and goals.
- Ask permission for recording and start recording.

Part A: Background

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1. What is the name and location of this sub-center?
2. What is your profession/job at this health center?
3. What are your main duties?
4. How large is the population covered by this sub-center?
5. Who else works in the sub-center?
6. Very briefly, what are their duties?

Part B: Patient related questions:

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7. Has it ever happened that, while treating a patient, you had to refer them to PHC, CHC or ZH?
8. If answer to above question is yes: did you transfer any kind of patient information, such as their past records, current medications, or any other information to higher-tiered health-centers?
9. If answer to the above question is yes, how did you transfer this information?
10. Do you write them referral slips? What information is written on slips?
11. Do patients have any health card/copy in which their past records are stored? If yes, do patients have to carry these with them to the health-centers?
12. What kind of patient records do you maintain? What information do you collect from patients?
13. How are these records transferred?
14. For what purposes are these records used?
15. How well is the current system for communicating patient history or status to higher tiered health-centers working?
16. From a technological point of view, what improvements could be made?

Part C: Medical Stock related questions:

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17. What kind of medical stock do you have?

18. If some particular stock item is exhausted, how do you restock it?
19. Do you notify anyone if stock is exhausted, or do you wait for it to be automatically supplied? Is this true for all kinds of stock?
20. Who do you notify if stock is exhausted? How do you notify them?
21. Do you or some other SC staff go and get the stock yourselves, or does someone come and deliver it?
22. If you go yourselves, from where do you get the stock?
23. What kind of medical stock is periodically supplied to the SC?
24. How frequently is this stock supplied to you?
25. From where does this stock come?
26. How long can it take for exhausted stock to be supplied?
27. Has it happened that you could not provide a patient with some medication or care because stock was not provided from the back end?
28. Do you maintain a daily stock register?
29. If yes, what information do you record in that register?
30. Why do you run out of stock?
31. How well is this system working? What do you like about it, and what challenges does it present?
32. Do you have any suggestions for how this can be improved, particularly from a technological point of view?

Part D: Technology related questions:
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33. Do you have a computer at this sub-center?
34. What kind of phone do you have? Do you or any other staff here have a smartphone?
35. If you have a smartphone, do you use internet/mobile data on your phone?
36. If present, how reliable is the internet? Mobile data?
37. How reliable is simple cell phone voice service here?
38. Approximately how many hours per week is the electricity supply down?
39. Would you be open to trying a cell phone based solution which tries to solve some of the above mentioned problems?

Part E: Miscellaneous questions:
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40. Of the people covered by your sub-center, what percentage would have Aadhar cards?
41. What other problems do you face while communicating information with (i) PHC, (ii) CHC or (iii) Zonal hospital?
42. Do you have some suggestion to improve coordination in patient/medical stock supply information at your sub-center?

Semi-Standardized Interview Questions for the Community Health Center

- Introduce ourselves.
- Explain our project and goals.
- Ask permission for recording and start recording.

Part A: General Background

What is the name and location of this health center? (For the record)

1. What is your profession/job at this health center?
2. What are your main duties?
3. Approximately what is the size of the population covered by this CHC?
4. Who others work in the CHC? Briefly, what are their duties? (lots of staff, so just a general idea)

Part B: Patient related questions: (similar to sub-center questions)
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5. Has it ever happened that, while treating a patient, you had to refer them to the ZH Mandi?
6. If answer to above question is yes: did you transfer any kind of patient information, such as their past records, current medications, or any other information to higher-tiered health centers?
7. If answer to the above question is yes, how did you transfer this information?
8. Do you write them referral slips? What information is written on these slips?
9. Do patients have any health card/copy in which their past records are stored? If yes, do patients have to carry these with them to the health centers?
10. What kind of patient records do you maintain? What information do you collect from patients?
11. How are these records transferred?
12. For what purposes are these records used?
13. How well is the current system for communicating patient history or status to other health centers (i.e. the ZH Mandi) working?
14. From a technological point of view, what improvements could be made?

Part C: Medical Stock related questions:
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15. What kind of medical stock do you have?
16. If some particular stock item is exhausted how do you restock it? (Let's not assume how it is restocked)
17. Do you notify anyone if stock is exhausted or do you wait for it to be automatically supplied? Is this true for all kinds of stock?
18. Who do you notify if stock is exhausted? How do you notify them?

19. Do you or some other staff at this CHC go and get the stock yourselves, or does someone come and deliver it?
20. If you go yourselves, from where do you get the stock?
21. What kind of medical stock is periodically supplied in the CHC?
22. How frequently is this stock supplied to you?
23. From where does this stock come?
24. How long can it take for exhausted stock to be supplied?
25. Has it happened that you could not provide a patient with some medication or treatment because stock was not provided from the back end?
26. It is our understanding that the CHC provides stock to the sub-centers in the Kataula block: can you briefly explain the process?
27. Has it happened that you could not provide sub-centers with their supplies on time because stock was not provided to you from the back end?
28. Why do you run out of stock?
29. How well is the current system working? What do you like about it, and what challenges does it present?
30. Do you have any suggestions for how this can be improved, particularly from technological point of view?

Part D: Mother Child Tracking System (MCTS) oriented questions
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31. Briefly, what role does the CHC play in the MCTS overall scheme?
32. Do sub-center staff come here monthly to enter their recorded data? Whose job is it to collect and enter the data?
33. How well is the the system working, from your perspective at the CHC?
34. Would an SMS based system where sub-center staff could send a text that would automatically fill in the database on an individual patient basis potentially make the process more efficient?
35. Are there other things that happen during the monthly visit to enter data that would still need to happen if the recorded data could be sent electronically?

Part D: Tech related questions:
---

36. Do you have computers at the CHC? What are they used for?
37. What kind of phone do you have? Do you have a smartphone?
38. Do other staff at here have a smartphone?
39. If they have smartphone: do you use internet/mobile data on your phone?
40. If present, how reliable is the internet? Mobile data?
41. How reliable is the cell phone service here?
42. Approximately how many hours per week is electricity supply down?
43. Would you be open to trying a cell phone based solution which tries to solve some of the above mentioned problems?

Semi-Standardized Interview Questions for Patients

1. Have you previously been referred between health centers?
2. Do you carry physical medical records with you when being referred to other centers?
3. Have you experienced long waiting times at higher level health centers?
4. Did doctors at higher level health centers have to repeat tests already performed at lower level centers?
5. After being treated at a higher level center, was the sub-center you came from updated with regards to your condition?
6. Do you think the process of healthcare coordination would be easier if records could be transferred electronically?
7. Do you have an Aadhar number?

Semi-Standardized Interview Questions to obtain feedback relating to VSIS Prototype

- Introduce ourselves.
- Explain our project and goals
- Ask permission for recording and start recording.
- Show, demonstrate, and **explain** prototype
- **Explain why we came to the decision to make this system**
    - Cellular service
    - Types of delays reported by SCs
- **Explain Goals**
    - Short term: Allow stock requests to go directly to zonal hospital to minimize delays
    - Long term: Potentially bypass the CHC as a point for stock delivery (i.e. ZH prepares stock directly for sub-centers)

Questions:

1. Do you see this system as being beneficial to stock delivery in the Mandi district?
2. Do you view bypassing the CHC as a point of stock delivery to be beneficial?
3. Does the pharmacist here have the capacity to respond directly to all SCs under your jurisdiction?
4. What modifications can be made to make this system more efficient and useful? What features would you like to see being implemented in the future?
5. How do you see this system adapting to the expansion of cellular data coverage?

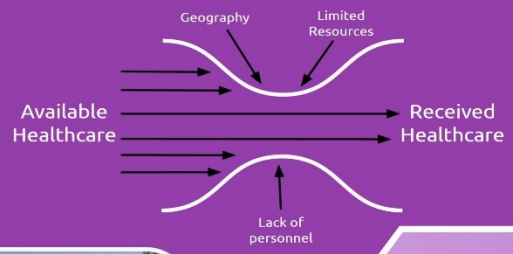
Improving Healthcare Coordination in the Mandi District

Gopal Aggarwal (B13121), Edward Dring, Naman Gupta (B13129), Victoria Johnson, and Jacob Maalouf

Abstract

Rural health workers in the Mandi District face unique challenges in providing quality care due to mountainous terrain and lack of supplies. This project evaluated the existing system of communication between health centers and identified areas in which the system could be improved to mitigate the effects of these challenges. We recommended a new system for medical stock requests and deliveries which could decrease delays by up to fifteen days and ultimately improve the quality of care for patients.

Problem



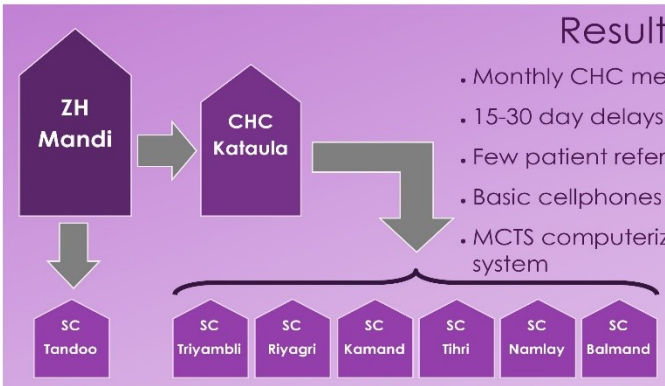
Goal

Support the development of **new communication systems for facilitating coordination** between healthcare providers in the Kataula Block.

Objectives & Methods

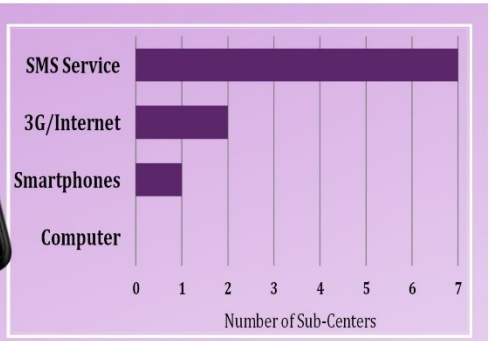
- Examine and Analyze Needs
  - Interviews and Site Assessment
- Identify and Rank Solutions
  - Feasibility Analysis and Selection
- Develop and Test Prototype
  - VSIS and Stakeholder Feedback

Results and Analysis



Coordination chart representing the flow of medical stock in the Katuala block.

- Monthly CHC meetings
- 15-30 day delays for stock
- Few patient referrals occur
- Basic cellphones given to sub-centers
- MCTS computerized system



Number of sub-centers with various kinds of technical capacity.

Visual Stock Indicator System (VSIS)

Desired Outcomes:

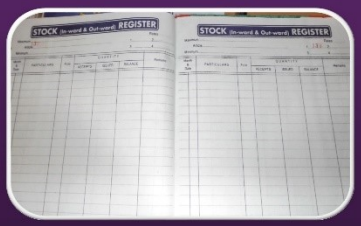
Immediate

- ⇒ Sub-centers directly notify ZH of needs
- ⇒ Decreased restocking delays

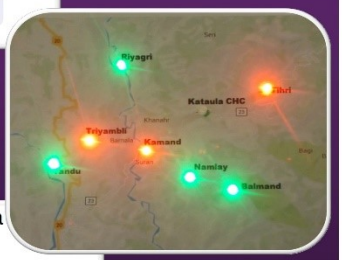
Long-term

- ⇒ Completely digitized communication system
- ⇒ Improved patient care

Before



After



Medical Stock Data

Health Center wise stock status is shown below.

Health Center	Stock Availability	Required stock	Stock Request time
Kamand	Stock Required	paracetamol	Sun Apr 24 2016
Triyambli	Stock Required	acetaminophen	Sun Apr 24 2016
Tihri	Stock Required	cetirizine	Sun Apr 24 2016
Navlay	Stock OK	NA	Sat Apr 23 2016
Balmand	Stock OK	NA	Sat Apr 23 2016

Acknowledgements

Thank you to all of our advisors: Dr. Varun Dutt, Dr. Stephen McCauley, Dr. Padmanaban Rajan, and Dr. Ingrid Shockey; as well as all health workers for their cooperation and kindness during interviews.

Links

We created a video detailing the specifics of using the VSIS, which is located at this link: https://youtu.be/SMysX8AG4Q8

We also created a video presentation of our fieldwork, located at this link: https://youtu.be/kT89TWLiq_s

The code for the VSIS is located at the following link: https://github.com/namangt68/visual_stock_indicator_system

Photos

Figure 10. The Zonal Hospital Mandi (Maalouf, 2016).

Figure 11. Interviewing at the Neri dispensary (Johnson, 2016).

Figure 12. Interviewing at the Namlay sub-center (Johnson, 2016).

Figure 13. Outside the Namlay sub-center (Johnson, 2016).

Figure 14. Outside the Tihri sub-center (Aggarwal, 2016).

Figure 15. Outside the Triyambli sub-center (Johnson, 2016).

Figure 16. Observing data entry at the Kataula CHC (Johnson, 2016).

Figure 17. Receiving feedback on the VSIS at the Kammand sub-center (Dring, 2016).

Figure 18. Receiving feedback on the VSIS at the Zonal Hospital Mandi (Dring, 2016).

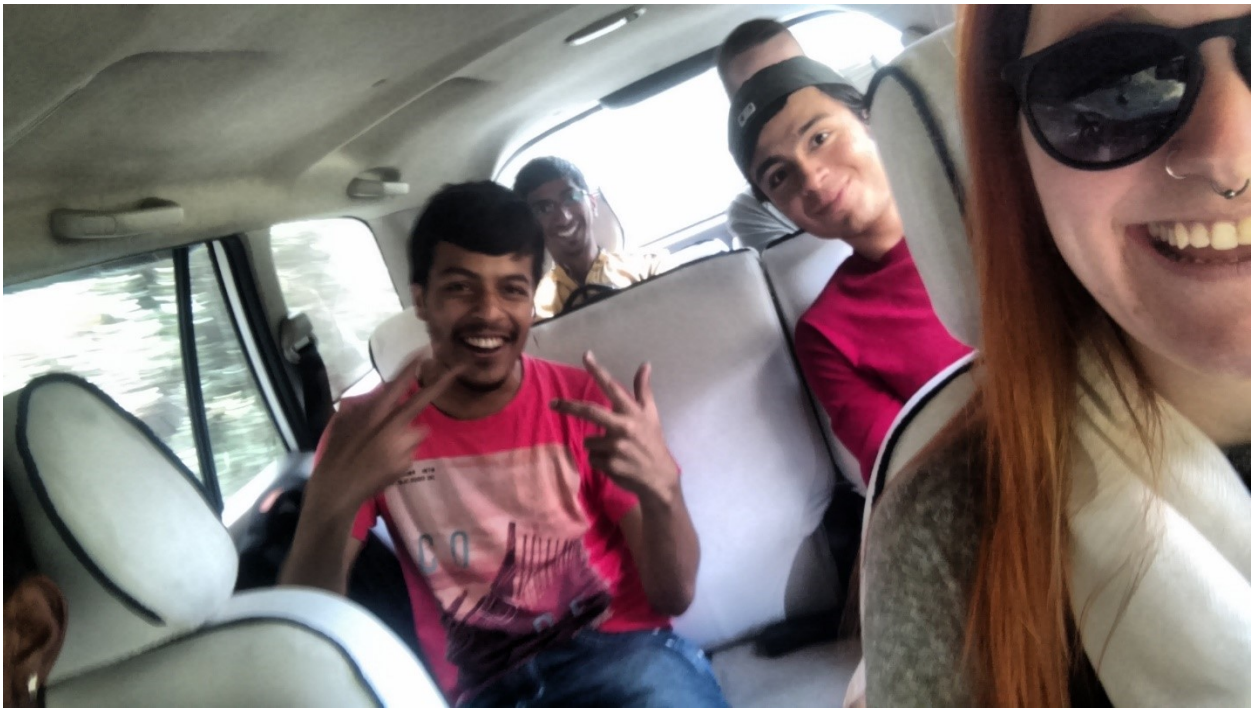


Figure 19. Driving to conduct interviews (Johnson, 2016).