

Improving the Provision of Primary Healthcare via Optimised Networks of Mobile Medical Units

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Proposal Summary

Expanding the reach of primary healthcare services is critical to improving health in the developing world. By increasing access to basic health services and coordinating care with more specialised services as needed, primary care can reduce hospitalisations and mortality, increase life expectancy, and deliver better overall health. [1] Hospitals and larger health clinics should be focused on the provision of specialised care, rather than burdened with the responsibility of providing primary care that could instead be provided more efficiently using alternative methods. [2]

Scaling is the process of expanding current primary healthcare services to reach more people. Large cities in the developing world mostly provide primary healthcare through a set of fixed, non-mobile health centres and hospitals. While there are benefits to this structure, it is much more difficult to scale primary healthcare services in this centralised system.

One possible solution that is currently being explored is to deliver primary care directly to the population. This is done via mobile medical units (MMUs). [3] The Indian government has introduced MMUs as part of the National Health Mission program in 2013. [4] There are still relatively few MMUs (1 per million residents in India), however both government and non-government MMUs have been successful [5][4] and the government aims to increase their number. As the number of active MMUs is set to increase, a system should be put in place to maximise their effectiveness.

The specific proposal is for the introduction of a system which would manage mobile medical units delivering primary care to those who are otherwise unable to visit their nearest primary care centre. This proposal describes the limitations of the current MMU system in India and proposes a revised system that draws inspiration from the efficient models adopted by modern western delivery services such as Uber and Deliveroo.



Figure 1: A typical MMU used as part of the National Health Mission in India.

Sustainable Development Goal Targets

SDG Targets supported: 3.1, 3.2, 3.3, 3.4, 3.8, 3.c, 3.d, 17.9

- 3.1: By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births.
- 3.2: By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births.
- 3.3: By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases.
- 3.4: By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.
- 3.8 Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all.
- 3.c Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing states.
- 3.d Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks.

This proposal does not uniquely support any of the SDG targets listed above. Instead, it aims to provide a more efficient and well co-ordinated primary healthcare delivery service and improve data collection and data interpretation. This intervention thus supports many of the SDG targets listed under Goal 3 - "Ensure healthy lives and promote wellbeing at all ages".

Trial Location

This system would be piloted in the city of Delhi. Delhi is the second largest city in India and is ranked last of all Indian cities for the provision of healthcare, with at least 1.8 of the 22 million population living in slums [6]. Despite the lack of primary healthcare in the city, under the National Health Mission (NHM) program, there were only two mobile medical units assigned to Delhi. Trialing this system in Delhi would allow us to test the effectiveness of multiple smaller MMUs (bikes and small cars) in serving patients in the slums. Trialing this system in Delhi also ensures a reliable internet access [7] and GPS coverage which is essential for the system to function efficiently. If this system is to be adopted elsewhere, it would be at least partly contingent on the achievement of SDG target 9.c: "Significantly increase access to information and communications technology and strive to provide universal and affordable access to the internet in least developed countries by 2020."

Trial Approach

The goal is to optimise the provision of primary healthcare services to a specific population with a given fleet of MMUs. Before a trial can be conducted, a number of issues need to be addressed:

- Firstly, medical staff are needed to operate the MMUs. Recruiting and training medical staff skilled in primary care will be necessary. This proposal does not envisage an entirely new medical organisation with new equipment and medical staff. It anticipates a new system of primary healthcare delivery supported by the Indian government and aims to optimise that system.

- Local political leaders and NGOs must be favourably disposed towards the project. It is also assumed that support from the local community can be obtained. Given the public outcry at the current standard of primary care in Delhi, it seems unlikely that a revised system would meet significant opposition from the community [8][9].
- As the system would be run under the government's continued NHM program, it is also assumed that local laws on data capture, management and usage will permit the implementation of the project.

There would be significant effort required to address the service design, staff training, management training, user and patient education, and to build relationships with local community and their leaders. In addition, financial constraints and all applicable laws and regulations governing health-care provision, telecommunications law and personal and clinical data usage and management must also be considered.

How could the system work?

The proposal envisages a fleet of small vehicles travelling directly to patients on a demand led basis. In each local community, a community leader with access to a mobile phone with an application (App) installed could be assigned as a contact for the system. In areas with better infrastructure and higher levels of smart phone ownership it might be possible to connect directly to the patient. Each of the MMUs has access to the application and acts as an independent agent. The technical problem is to optimise the provision of primary healthcare services to a specific population with the given fleet. This proposal envisages using technology similar to that used in European or American cities for the delivery of food or taxis e.g. Deliveroo or Uber. There is no central manned control centre directing the MMUs. The MMU will go where the system directs based on the requests from patients using the App.

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1. A member of the population is sick.
2. The patient or someone in local community uses the app to signal for medical assistance. The app uses GPS to locate the patient. If GPS is not available, manual entry of the address is possible.
3. The request is registered on the system. First, the application determines the type of MMU that is needed (motorbike, car or van). Based on the current state of each agent in the fleet of MMUs, the app assigns an agent/MMU to the patient. The system decides in real time the most efficient provision of services given the current state of the system.
4. Upon arrival, the MMU treats the patient if possible or refers the patient to a more specialised service.
5. The MMU registers the visit; noting patient details, diagnosis and outcome on the application. Location, time, date are recorded automatically.
6. Issues concerning the patient identified by the MMU can also be recorded for the purpose of ongoing healthcare planning.

Comments on Optimisation and Model Flexibility:

Calculations determining optimal configurations of MMUs are made using known variables such as urgency, distance, availability of the different MMU vehicle types, and many other dynamic factors. Each of these factors can be weighted positively or negatively depending on the parameter the government wants to prioritise at a given time. Placing more weight on a certain parameter during calculations means that this parameter has a greater influence when deciding the optimal configuration of MMUs, thus influencing the overall behaviour of the system. The true potential of the technology is now apparent. The flexibility afforded by this system would allow the Indian government to tailor behaviour of the network of MMUs according to ongoing healthcare needs.

Estimated Benefits

In addition to acting as the patient's or community's access point to the medical system the app would also serve as a tool for data collection. If enough families had access to the app and agreed to upload their data to it then large quantities of health, population and epidemiological data could be gathered. This data would allow the system to discover and assess population and epidemiological trends in real time, with resulting improvements in population-based health initiatives such as disease control and vaccination program management.

Listed below are the high-level estimate of the benefits, assuming effective implementation of the pilot.

- **Improved healthcare and outcomes for the population**, especially for the infirm, the old and the young. These improvements help to achieve SDG target 3.8: "Achieve universal health coverage, including financial risk protection, access to quality essential healthcare services and access to safe, effective, quality and affordable essential medicines and vaccines for all."
- **Improved access to maternal healthcare.** India's current maternal mortality ratio is 130 per 100,000 live births. The majority of maternal mortalities in India are primarily a result of the fact that many women do not give birth in a hospital or health centre. This lack of access to primary healthcare during and following childbirth can lead complications such as excessive bleeding or infection to go untreated [10]. Only a quarter of pregnant women have full antenatal check-up [11] [12]. These issues are fundamentally access issues which can be solved by expanding the reach of primary services. Improving access to maternal healthcare services will help to achieve SDG target 3.1 by 2030: "reduce the global maternal mortality ratio to less than 70 per 100,000 live births."
- **Improved access to healthcare for newborns and young children.** The current Neonatal Mortality Rate in India is 28 per 1,000 live births. Given the infant and under-five child mortality rates of 40 and 49 per 1,000 live births respectively, 70% of total infant deaths, and more than half of under-five deaths fall in the neonatal period [11]. A study on the state of newborn health in India warned that the goals set out by the UNICEF progress report "Committing to Child Survival: A Promise Renewed" [13] aiming to under-five mortality to 20 or less per 1,000 live births by 2035 would not be attained unless specific measures were made to reduce newborn mortality [12]. The improved access to neonatal care and childcare provided by a proper implementation of this system would help to achieve the goals set out by both the UNICEF report and SDG target 3.2.
- **Increased knowledge regarding population health.** The improved ability to gather epidemiological data and monitor the spread of communicable disease in real time facilitates the implementation of well-informed population-based health initiatives. Strengthening the capacity for early warning and risk reduction will help to achieve both SDG targets 3.3 and 3.d by 2030.
- Another major benefit would be the **automatic gathering of information** about the patient, their family and their health, and the benefits that this offers in terms of patient management. For example the administration of the Indian health care system is paper based at all levels. This creates tremendous inefficiency and potential for error in case management. This proposed system could help change this at least at a local level.
- **Capacity Building.** This approach to healthcare delivery being fundamentally about communication, technology transfer, and the introduction of new models of service delivery to different communities will aid with capacity building in those areas.
- The lessons learned from a successful pilot could be valuable to other technology based health initiatives the Indian government would implement.

Measurement of Outcome

The primary goal of this technology is to increase the access to primary care. Data gathered from an effective pilot should reflect this increase. Assessing the effectiveness of the pilot would include consideration of the following:

- The number of patients who have used the system to access primary care. This number would then be compared to the number of patients currently visiting existing primary care centres to see if more patients were accessing primary care services with the new system. As each visit is automatically recorded on the system, this data is readily available. Data for primary healthcare centres can be taken from government records.
- The number of patients recruited to the system. Again this data is recorded automatically by the system.
- The reduction in numbers attending local hospitals. If the system is effective, the number of patients attending local hospitals should decrease. This data can be acquired from the hospital's records, or data gathered on waiting times in local hospitals.
- Local mortality rate improvements in neonatal, maternal, and under-five mortality rates.
- The average cost per patient seen with the new system against average cost per patient seen with the old system. This would be the total cost of primary care services divided by the number of patients seen. This could be used as an indicator of financial sustainability.

Potential Risks to Project

The proposed system will only function optimally if the population understands the system and the technology well enough to use it properly. Furthermore, it is assumed that the user is competent and honest with regards to providing information both when requesting an MMU and when asked to give data. Failing to educate the population about the system would significantly reduce the effectiveness of this intervention.

As this type of system is alien and new to most people, it is possible that it will be met with scepticism and mistrust by communities. Support from community leaders is crucial to ensuring that the system is adopted and accepted by these communities.

Naturally, the support of the Indian government and its NHM program is necessary for this trial to succeed.

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