


BMJ Open Cost analysis of a mobile medical unit programme in Andhra Pradesh: a microcosting study protocol

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ABSTRACT

Introduction Offering primary healthcare through mobile medical units is an innovative way to reach the rural and the vulnerable population. With 292 mobile medical units, the Andhra Pradesh mobile medical unit (APMMU) programme is one of the largest health outreach programmes in rural India. However, India lacks reliable cost estimates for the health services delivered through mobile medical platforms. This study aims to estimate the unit cost of providing primary care services through mobile medical units in rural and tribal areas of Andhra Pradesh. **Method and analysis** Cost analysis of 12 mobile medical units will be undertaken. We will use the activity-based microcosting technique from the providers' perspective. A bottom-up approach will be used for cost estimation.

Standardised tools will be used to collect data on activities and resources, and on the costs. Capital investments and recurrent costs will be measured and evaluated. Average unit costs, along with 95% CIs, will be reported. Sensitivity analysis will assess the cost estimate uncertainties and other cost assumptions.

Ethics and dissemination Piramal Swasthya Management Research Institute's ethics committee approved the study. The findings of the study will be disseminated through conference presentations, publications in peer-reviewed journals and advocacy with the national and state governments. This study will provide first-hand comprehensive cost estimates of provisioning primary healthcare services using mobile medical units in India.

BACKGROUND

Rural India accounts for nearly 69% of the total population but has only 26% of total hospital beds and 33% of the total healthcare professionals.^{1–3} Due to the unequal distribution of healthcare resources, the rural public health system in India remains inefficient.

The primary reasons for these inefficiencies include an inadequate number of health facilities, chronic human resource shortage and frequent drug stockouts, particularly in rural public health facilities.⁴ In 2017, there was a 24%, 21%, 17.3% and 14.5% shortfall of government health facilities, medical doctors, nurses and pharmacists providing

Strengths and limitations of this study

- The study applies existing microcosting methodology to the context of mobile medical units.
- The study samples a large and representative number of mobile medical units in rural and tribal Andhra Pradesh, India.
- The costing methodology is from the healthcare providers' perspective.
- Economic evaluation to study the effectiveness of mobile medical platforms in delivering primary healthcare services is suggested.

primary healthcare services, respectively.^{5–8} The average rate of absenteeism among the available staff is as high as 40%, and people often have to travel more than 6 km to reach primary healthcare centres.⁹ Rural realities of steep terrain, infrequent transport services, illiteracy and economic constraints further impose barriers to health service utilisation and push people to seek care from the unorganised, informal and costly private healthcare sector.¹⁰

Evidence suggests that only 11.5% of rural households sought primary level outpatient care (except for childbirth) in public health facilities, and the average medical expenditure of rural households is on the rise. For example, the average expenditure (per person per fortnight) for outpatient care in rural India has increased from US\$29.4 in 2004 to US\$55 in 2011.^{11 12} Provisioning of quality primary healthcare to rural people is, therefore, of utmost importance to improve access to healthcare services and protect them from catastrophic expenditures.

To make primary care available and accessible in rural areas, the Government of India rolled out Mobile Medical Unit (MMU) service under its flagship health programme, The 'National Health Mission'. The purpose of MMUs is to provide basic primary care

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services to the population living in remote and under-served areas close to their homes.¹³

An MMU has five-member staff (a doctor, nurse, lab technician, pharmacist and a driver) and is equipped with basic diagnostic equipment and medicines. Preventive, promotive, diagnostic, curative and referral healthcare are some of the services delivered through the network of MMUs. For service delivery, each MMU makes monthly, fixed day and date visits in the assigned villages as per the predefined route and schedule. Accredited social health activists, who are from the same village, inform the key informants and community members of their respective village a day prior to the MMU visit.¹³

MMUs today have gained widespread acceptance in India and there are 1569 functional MMUs operational in 29 states of India.¹⁴ The Government of Andhra Pradesh, in partnership with Piramal Swasthya Management and Research Institute, alone, ran a fleet of 292 MMUs till March 2019.¹⁵

There is enough evidence demonstrating the utility of MMU platform in facilitating access to healthcare services, reducing patients' cost (out of pocket expenditure), improving early detection of diseases and building referrals, especially, for minority groups.^{16–18} The model developed called the 'Knowledgeable Neighbours', by the Harvard Medical school has also shown effectiveness of MMUs in terms of screening for non-communicable diseases.¹⁷ However, despite extensive use, there are no reliable cost estimates for the health services delivered through such mobile medical platform. This information is important for policymakers, in addition to the evidence on the efficacy and effectiveness, in order to make informed investment decisions. Essentially the decision-makers in different parts of the country face a dilemma when it comes to delivery of health services through mobile platforms. They often need to know the cost of operating mobile units from providers perspective, so as to convert it into a large comprehensive and scalable programme, balancing population needs, geographical coverage and available input resources such as budgets. In this study, we highlight the methodological details to estimate the unit cost of providing primary care services through MMUs in rural areas of Andhra Pradesh.

AIMS AND OBJECTIVES

The specific objective of the study is to estimate the cost of primary healthcare service delivery through the MMU platform from the providers' perspective in rural Andhra Pradesh, India.

METHODS AND ANALYSIS

Study design

This is a microcosting, cross-sectional mixed-method analytical study.

Study period

Originally study was planned from March 2020 to September 2020 however due to COVID-19, we plan to

conduct this study after the pandemic. We assume data collection period to be 4 months from time of study initiation.

Study settings

We will conduct this study in rural Andhra Pradesh, where the APMMU programme is in operation. Andhra Pradesh is primarily a rural state with 66% of the population living in rural areas.¹⁸ The state is divided into two geographical areas¹ Rayalaseema and² Coastal Andhra Pradesh. Rayalaseema is the inland south-western part and Coastal Andhra Pradesh is on the east and north-east and has the second-most longest coastline in India.

The APMMU programme

The APMMU programme started in 2016, is once-a-month, fixed day, free, community outreach service at the village level. A network of 292 MMUs offer primary healthcare services (non-emergency) to beneficiaries of all ages in 13,523 villages across 13 districts of Andhra Pradesh state, India. The programme aims for equitable health access to the vulnerable and marginalised rural and tribal population. The programme scope includes providing promotive (health awareness camps), preventive (counselling of programme beneficiaries for a healthy lifestyle), diagnostic (random blood sugar, haemoglobin test, urine for protein, urine for sugar, malaria—rapid diagnostic test, urine pregnancy test), therapeutic (medicine prescription) and referral services (referral to nearby government health facilities for further diagnosis, confirmation and or treatment). Pregnant mothers and children get antenatal and postnatal check-ups. In addition to providing medical services, the MMU also conducts chlorination of the local water bodies in the village. The MMUs remain operational 24 days a month and deliver primary healthcare services to the rural and tribal population residing at least 5 km away from any public health facility. An MMU covers a village of approximately 1,500 population each in the morning (10:00 AM to 1:30 PM) and in the afternoon (2:30 PM to 5:30 PM) everyday. Overall 20,000 beneficiaries are served for various acute and chronic health conditions in a day. There is no prior booking system and anyone can walk-in for availing the programme services. The programme service delivery is uniform across all MMUs and beneficiaries are not prioritised as this is a non-emergency healthcare programme.

Additionally, every MMU is fitted with a global positioning system (for real-time location tracking), a biometric device (for staff attendance), an electronic medical record system and 51 types of medical instruments. The nurse has a laptop while the laboratory technician and the pharmacists have a tablet each to record patient data. The nurse uploads and synchronises the day's data onto a central server at the day's end. Data are directly fed into government dashboards and aggregated service utilisation information such as the number of patients served, and types of health conditions among

beneficiaries and so on are presented on a near-real-time basis.

Patient and public involvement

No patients will be involved in the study.

Sampling and sample size

We will use a three-step multistage sampling.

Stage 1

Listing of all districts in Andhra Pradesh. Based on the difficulty score (β)-related to programme implementation, all districts will be categorised into ‘low (20.0–26.9)’, ‘medium (27.0–35.0)’ and ‘high (35.1–50)’ difficulty districts. The difficulty score (β) is an estimate of the difficulty involved in implementing the MMU project in different geographical areas. The difficulty score (β) is calculated based on four variables namely, percentage of tribal population, percentage rural population, population density and MMU coverage in the village.

Difficulty score calculation: we constructed β by weighting the following variables-

1. Population density score of district (density of population per square kilometre* 0.3).
2. Tribal score of district (% of tribal population to total district population*0.3).
3. Rural score of district (% of rural population to the total district population*0.2).
4. The coverage of MMU districts wise (number of villages in district divided by number of MMUs and then multiplied by weightage factor 0.2).

Summation of the four scores above gives the beta score.

The weighing factors (0.3, 0.3, 0.2 and 0.2 as mentioned above) were developed in consultation with health experts in programme management (districts/state programme managers) and the local health authorities (nodal district/state programme officer).

Stage 2

We will randomly select two districts from each of the three categories described in stage 1. This will give us a total of six districts.

Stage 3

All MMUs present in these six districts will be listed. We will randomly select two MMUs per district, whose average distance travelled in a month is within two SDs of the average distance travelled by all MMUs in the district. One MMU each, that satisfy the above criteria, will be selected from the tribal and rural area. The main advantage of taking this method is that we assume distance travelled by the MMU and geographical terrain will also reflect on the unit cost of services delivered.¹⁹

Sample size

Cost analysis is the first step of partial economic evaluation.²⁰ We will select 12 MMUs from the six districts,

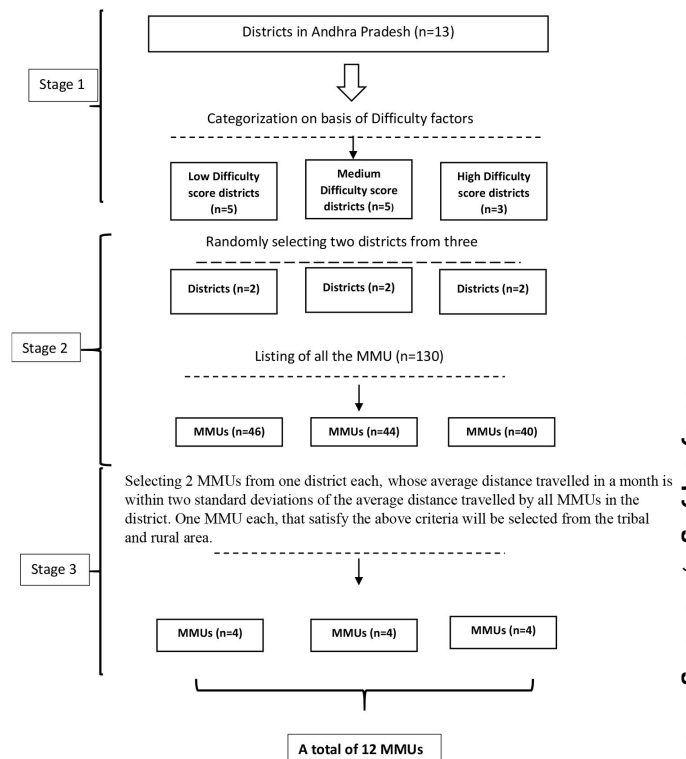


Figure 1 Schematic representation of sampling. MMU, mobile medical unit.

which is around 10% of the total MMUs in the selected six districts (figure 1).

Costing methodology

The activity-based microcosting approach of cost analysis will be applied. The activity-based costing has high granularity as it enlists, quantifies and values every single item required in the production of service.²¹

Types of cost

We will collect data on capital and recurrent resources (table 1) used for delivering mobile health services in the year 2019–2020. The capital cost will include building space, equipment/appliances, the vehicle, including the start-up cost (cost incurred to initiate any new activity

Table 1 Capital and recurring cost for MMU project in rural Andhra Pradesh (2019–2020)

Capital cost (online supplemental annexure 1)	Recurring cost (online supplemental annexure 2)
Building/rental space, equipment/appliances, vehicle	Human resource, medicines, consumables, diagnostics
Start-up activities: activities that last until the end of the project	Overheads for example, office expenditure, maintenance, bills travel, etc.
One-time activity: training, workshops, etc.	Training, workshops and information, education and communication activities

MMU, mobile medical unit.



during the reference period). Trainings not repeated within 1 year will be considered as capital costs. Staff salaries, consumables (drugs), fuel (diesel/petrol) and vehicle maintenance cost will fall under the recurrent costs.

Data collection

We will use a mixed-method approach employing a primary survey (using a quantitative tool and qualitative interviews) and secondary review of retrospectively collected routine programme data.

Primary survey

The primary survey will collect data from two levels, that is, the programme administration level (state, regional and district and MMU project head office) and the MMU level (field). We will use the Facility Costing Tool (FCT) (online supplemental annexure 1) and Mobile Medical Unit Assessment tool (MMUA) (online supplemental annexure 2) at the programme administration level and MMU level, respectively. The MMUA and FCT tool will collect data on the quantities of items such as human resources, drugs and consumables, medical and non-medical items and qualitative responses like the time required to perform different activities, number of items required to perform the activities through open-ended questions. We will interview the expert panel using a structured interview schedule (online supplemental annexure 3) to arrive at the allocation ratio and time spent on the production of shared services.

Secondary review

The secondary data will be extracted from the routine administration (patient load at MMUs, types of services used) and financial reports (purchasing prices of the capital and recurrent items, life year of the capital items, utility expenditure) of the programme.

Since we plan to use the bottom-up approach, therefore, the cost estimation exercise using MMUA tool at MMU level will be first completed. The FCT will be used at the regional administration, district administration and finally at the state level.

The collected data will allow us to partition the cost into different levels (MMU level, district level, regional and state level) and to align with the WHO's Choosing Intervention that are cost-effective methodology.²² Both tools will be used to estimate the various quantities of inputs like human resources, overheads, utility, building, equipment use and cost. This will ensure that with every level of costing, our estimate becomes more precise.²¹

Table 2 below shows the number of MMU administrative facilities and key informants to be costed and interviewed at programme implementation and administration level for the primary data collection.

Table 3 below gives an overview of cost elements, data sources, allocation to the services and the tools to be referred.

Table 2 Costing survey on various level with key informant estimate

Costing level	Number (s)	Number of personnel involved in the survey	Number of human resources in the survey	Type of data to be collected
MMUs (field level)*	12	5	60	Quantitative and qualitative
Programme office (state)†	1	6	15–20	Quantitative and qualitative
Regional offices (regions)†	2	3	20–22	Quantitative and qualitative
Central drug store (district)†	1	2	2–3	Quantitative
Head office (state)†	1	4–6	4–6	Quantitative and qualitative
District offices (district)†	6	3–4	10–14	Quantitative and qualitative
Total	17	23–26	100–115	

*Programme implementation level.

†Programme administration level.
MMU, mobile medical unit.

Study outcomes

The study will clearly differentiate between the capital and recurrent costs (detailed in online supplemental annexures 1 and 2). Once we have capital and recurrent costs, we will use the step-down approach for the allocation of the cost in terms of various services provided under the MMU platform. Study outcomes are detailed in online supplemental annexure 4.

Data management and analysis

Two field researchers (graduate in social science or an associated field) will receive training in costing methodologies and data collection procedures. The training will be followed by hands-on piloting of the tools in the field. The standard training manual of the WHO on cost analysis will be used.²³

We will collect information on the price and quantity of items consumed within a given input systematically. We will prepare a list of items (types and quantities) and the monetary value of each item based on their market prices. Adjustment to prices will be done if the prices of government purchased resources (drugs, consumables, equipment etc) are skewed compared to the actual market prices. We consider resources purchased by the government skewed towards the government because the government purchases in bulk and from the big buyers, giving government bargaining power for overall lower prices. And hence, we will adjust the cost of the items to reflect the true market value. The annual cost of each type of input will be calculated by combining/multiplying the unit price of services by the number of units consumed in a year.

All cost calculations will be done from the providers' perspective using a bottom-up approach. We will not measure patient-level direct or indirect costs. All prices

Table 3 Data points for allocation of cost, data sources (tools used FCT)

Data points at the MMU/admin level	Data elements	Data sources	Allocation	Reference to the annexure and section
Salary	Number of hours working in the day, working days in a year, leave etc	Payslips	The proportion of time spent on MMU-related work through timesheet record	Expert panel interview schedule
Overheads	Electricity, water, internet, audit expense	Office records	The proportion of overheads used for MMU services	MMUA and FCT
Building/rental space	Built area, open area	Facility survey	The proportion of MMU services served by the facility	MMUA and FCT
Equipment	Medical, non-medical	Facility survey and non-consumable registers	The proportion of time spent on different activities/work by concerned staff	MMUA, FCT and expert panel interview schedule
Travel	MMU outreach, diesel monthly cost, maintenance	Travel diaries	The proportion of time spent on different MMU work	MMUA, FCT and expert panel interview schedule
Drugs and consumables	Antihypertensives, Antidiabetic, etc	Pharmacy stock registers	The proportion of MMU patients served by the facility	MMUA, FCT and expert panel interview schedule
IEC costs (banners, wall paintings, etc)	Print material, audio-visual	Office records	The proportion of patients among total population benefiting from IEC	MMUA and FCT
Training (honorarium, travel, space, equipment and time costs)	Software training, induction training, refresher training in MMU	Office records	100% only for intervention area or proportion of training on MMU	MMUA and FCT

FCT, facility costing tool; IEC, information, education and communication; MMU, mobile medical unit.

will be converted to the level of prices in 2020 using the gross domestic product deflators.²⁴

Data analysis will be done to estimate the unit cost of delivering primary care services through MMUs.

The results will be reported adopting the Global Health Cost Consortium's results reporting format.²⁵ The final cost estimates (in rupees) will be converted to the US dollars using exchange rate/purchasing power parity for international comparison and generalisability.²⁶

For costing the inflation adjustment will be made for making it comparable concerning the year of costing.²⁴ Uncertainty in all the cost estimation studies is inherently present. To counter these uncertainties in cost estimation, we will ensure that the magnitude of uncertainty is kept at an acceptable range by using univariate sensitivity analysis.²⁷ There is a presence of price variability of items like drugs, consumables and so on, and product differentiation is very common in the market.²⁸ And in some cases, it will be difficult to get the prices of the items due to various reasons. The univariate sensitivity analysis will be applied to changing cost and the volume of beneficiaries to assess level of coverage of APMMU services. Further, the base value of salaries, price of equipment, building cost, rental prices and assumptions on time allocation will be varied by 25% on both sides. If the prices of drugs and consumables show wide variation, we will vary them by 90% on lower limit to 100% on upper limit on the average price of the drugs and consumables prevailing in the costing year (2020–2021). We will also estimate the sensitivity of the annual cost and unit cost for providing overall MMU services to variations in discount rates at 3% and 10%.²⁹

Data will be collected on paper and will be entered into Microsoft excel 2016. The principal investigator will access the data files weekly for quality assurance. Logic and range checks will be used to minimise errors in the data entry process and identifying missing data or problem with the completed data. The paper and electronic data will be preserved for 3 years from the date of study completion.

ETHICAL CONSIDERATIONS AND STUDY DISSEMINATION

Piramal Swasthya Management Research Institute ethics committee approved the research study (PSMRI/2019/10). There is no contact with patients and all data are collected from staff members and healthcare workers. Written consent will be taken before conducting any interviews. The findings of the study will be disseminated through conference presentations, publications in peer-reviewed journals and advocacy with the national and state governments.

STUDY STATUS

Ethical approval and training of data collectors have been completed in January 2020. However, due to COVID-19, we anticipate data collection beginning not before November 2020.

SIGNIFICANCE OF THE STUDY

This study will give unit cost estimates of offering various primary care services like general medicine, gynaecology and obstetrics care through MMUs in rural and

tribal areas of Andhra Pradesh. Furthermore, it will also provide insights into the difference in resources used and costs incurred. Thereby, aiding in the planning of quality care and improving health systems performance by increasing efficiency.³⁰ This study could potentially provide a rationale for either scaling up, scaling down or discontinuing the use of MMU as a model for healthcare service delivery in far-flung and difficult to reach areas of India. This study will generate cost estimates for different components of the MMU programme like capital, recurrent and total cost. This will help in the identification of efficient and inefficient services that can be either scaled up, scaled-down or removed.

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Contributors AR, VD and SKH conceived the study concept. VD contributed to the preparation of the protocol and study tools. AG helped in writing the protocol. AR, VD, AG and SKH contributed to the development of research methods. NR contributed in refining first draft and is responsible for program management. All authors read and approved the final protocol version.

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