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COST-EFFICIENT EVALUATION OF AMBULANCE SERVICES FOR COMMUNITY CRITICAL CARE TRANSPORT NEEDS IN MACHAKOS COUNTY, KENYA.

F. W. Muchiri, BSc, Jomo Kenyatta University of Science and Technology, J. Kariuki, BSc, MSc, Center for Public Health Research (CPHR), Kenya Medical Research Institute, D. Otundo, BSc, Health Statistics Division, Ministry of Health, Machakos County, L. Mwangandi, BSc, MSc, Medical Biochemistry Department, Mt Kenya University and S. Karanja, BSc, MSc, PhD, Department of Health, College of Health sciences, Jomo Kenyatta University of Science and Technology, P.O.Box. 62000-00100, Nairobi, Kenya.

Request for reprints to: F.W. Muchiri, College of Health Sciences, Jomo Kenyatta, University of Agriculture and Technology, P.O Box 26086-00100, Nairobi, Kenya.

COST-EFFICIENT EVALUATION OF AMBULANCE SERVICES FOR COMMUNITY CRITICAL CARE TRANSPORT NEEDS IN MACHAKOS COUNTY, KENYA.

F. W. MUCHIRI, J. KARIUKI, D. OTUNDO, L. MWAGANDI and S. KARANJA.

ABSTRACT

Background: Machakos County is one of the 47 counties in Kenya. In the current study performance of ambulance services were measured using indicators such as response time, on-scene time, clients' satisfaction and cost-efficiency (technical).

Objectives: To determine the cost-efficient ambulance services appropriate for community critical care transport needs in Machakos County.

Design: Descriptive cross sectional study.

Setting: Machakos County (Emergencies Services Department)

Subjects: Publically financed ambulances

Results: Machakos has seventy Basic Life Support (BLS) ambulances distributed among the 69 administrative locations (wards). A total of 12,674 victims were transported to different tares of hospital and referrals between March 2014 to May 2015. Victims requiring emergency obstetric care (EMOC) accounted for 24.7% of victims transported, road traffic accidents victims 10.3% and the least were rape victims at 0.03%. The annual operational cost was Kshs. 70,328,627 (USD 717,639.05). Expenditure profiles indicated that staff wages accounted for 49% of total operational cost, overheads costs accounted for 33.5%, while office rent accounted for 1.36%. The mean unit cost per kilometer was Kshs. 30.9 (USD 0.32) and cost per victim transported by an ambulance was Kshs. 6,504 (USD 66.37). Key demand factors were social cultural and health seeking behaviours of residents. The supply barriers were transport costs, operational costs and in-efficient signage on roads for direction. The mean cost-efficiency (technical) of Machakos ambulance transport services was 90.6% (C.I 82.7% - 98.2%).

Conclusion: Machakos County Government ambulance services was technically efficient operating.

INTRODUCTION

Throughout the world, performance of ambulance services is measured using indicators such as technical efficiency, response time, on-scene time and clients' satisfaction (1). Delivery of efficient emergency medical services (EMS) is critical in reducing mortality and disability rates, some studies have found important relationship between response time and mortality rate (2).

Transport and road infrastructure play key roles in the overall delivery of and access to health services, and by extension, contribute to the effectiveness of health referral process (3). Many households do

not have reliable, suitable and affordable transport services that are essential for access to care during critical periods such as when life-threatening conditions occur either at home or outside environment. Emergency access to care is also critical especially during childbirth-related complications which are unpredictable and majority of births in developing countries continue to take place at home (3). Various financial, social and institutional factors of supply and demand impose severe constraints on the effectiveness modes of transport. Moreover, families in low resource settings often cannot afford the costs of ambulance services (4). Other factors that potentially contribute to delay in access of emergency

care include health seeking behavior, availability of suitable transport, and perceived availability and quality of health services.

Majority of sub-Saharan Africa and Asian countries have been unable to sustain the fleet of ambulances and other vehicles which had been envisaged as part of a publicly-funded health service. As a result, ambulances are used only to transfer patients between health facilities and not from the scenes of injury / accidents or from their homes (5). Moreover, privately operated ambulances are rarely available in many rural areas, and where available are not affordable.

Like elsewhere in the world, Kenya has been encouraged to develop performance measures that satisfy the need for improved accountability, and promote more effective and efficient operational management. The services have been devolved to the 47 counties Machakos being one of them. The counties are under pressure to develop the best ambulance service performance management system that satisfy the needs of community members. Unfortunately, like in Australia and other nations there are few validated indicators of effectiveness and quality in ambulance systems or emergency medical systems, and therefore few universally accepted methods of measurement (6, 7). This situation exists despite the considerable efforts made to develop, collect and analyse performance indicators. Some of these are irrelevant to system design, quality or effectiveness, while others that might be useful may not have been readily measurable because these data were un-collectable or inaccurate due to the problems of data linkage between health institutions or non-compliance (8, 9).

MATERIALS AND METHODS

This Study was conducted in Machakos County. At present there is a total fleet of 70 ambulances in the County. The county operated a community based ambulance service at the period of study as opposed to the former regime which was hospital based. This system was initiated to bring services closer to the citizens as well as improve ambulance service delivery. Further, seeking improved consumer satisfaction, reduced maternal mortality and road traffic accidents due to delayed medical attention. Study design - A descriptive cross-sectional study design was used.

Study population: Ambulances operated by the government of Machakos County.

Data collection: Cost data were collected from the County ambulance services for a period of one year from the relevant sources. These included all the cost incurred by the County in running the ambulance services (Table 1). This was achieved by identifying the various sources of costs like; ambulance overheads cost and medical consumables so as to allocate costs

associated with delivery of ambulance services. Staff salaries, medical consumables and recurrent overheads cost consisted some of the recurrent costs. Capital resources were vehicles, motorbikes, buildings and ambulance fitted equipments. Overheads cost consisted of; monthly payments of water, electricity, internet, repair and servicing of vehicles and annual insurance cover.

Other costs were; IEC (Information, Education and Communication), cost of administration and office/ call centre equipments.

Data sources: Financial records for the period ambulances had been running were assessed to collect the data for expenditure incurred on ambulances (both capital expense at the time of purchase and recurring such as repair and insurance) and medical consumables. For human resource, salaries were not available due to a clause in the policy of non-disclosure of staff salaries, based on the finding of Prinja. S. *et al.* 2013, who found in their study that salaries comprised between 35-49% of the total cost, the staff salaries was calculated. For space and infrastructure costs, estimates for rental price of a similar space was obtained from a survey of real estate property dealers in the local area. Vehicle logbooks were reviewed to obtain data on mileage travelled, number of patients transported and petrol consumption. Similar procedure was followed for other equipment when prices were unavailable. The other set of data was collected by interviewing the fleet manager, human resource manager and the procurement officers.

Data analysis: Data Envelopment Analysis (DEA) was used to assess the cost-efficiency (technical). The technical efficiency scores were computed using data envelopment analysis programme, version 2.1 (DEAP 2.1) designed by Coelli (11). The model was based on two inputs (cost incurred on vehicles and consumables) and one output (kilometers covered monthly by an ambulance). The focus was on output oriented technical efficiency which seeks to answer how output quantities can be expanded without changing the inputs. A constant returns to scale assumption was made. Data envelopment analysis employs linear programming techniques to compute the efficiency scores for the ambulances.

Theme based analysis were conducted on information obtained from the key informants interviews. The outputs were used to explain some the demand and supply patterns from the findings.

Ethical considerations: Approval to carry out the study was obtained from Kenyatta National Hospital/ University of Nairobi (KNH/UON) Ethical Review Committee. Informed consent was also obtained from the participants in the study.

RESULTS

In the periods starting March 2014 to May 2015, a total of 12,674 cases were transported by ambulances from locations to various tiers of hospitals based on the classification of victims. Classification found being used by the county. Victims presenting with severe conditions accounted for 62% while the least was Life threatening conditions at 5%. Figure 1 profiles the various emergency conditions as transported by the ambulances.

Conditions: Victims in need of Emergency Obstetric Care (EMOC) accounted for 24.7% of all cases transported by the ambulance services. Other victims transported by the ambulance included; victims of road traffic accidents at 10.3%, respiratory disorders at 9.26% and those suffering from gastrointestinal disorders at 8.6%. Rape victims were least transported at 0.03%. Table 1 profiles cases (victims) transported by ambulances for a period of 15 months.

Figure 1
Profiles of victims transported with emergency conditions by the ambulances

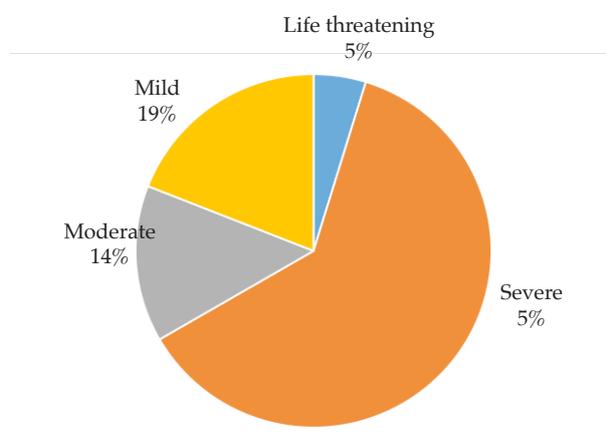


Table 1
Distribution of cases (victims) transported by ambulances over a period of 15 months

Conditions Categories	Types of Cases	10 months ending Dec 2014	Period, 2015					TOTAL	Percentage (%)
			JAN	FEB	MAR	APRIL	MAY		
Life threatening	EMOC (Deliveries and its complications)	2,371	167	141	196	144	134	3,153	24.7%
Severe	Alcoholic coma / intoxication	148	7	4	3	3	4	169	1.3%
Severe	Assault cases	186	0	13	16	14	9	238	1.9%
Severe	Burns	82	3	9	9	7	5	115	0.9%
Severe	Cancers	66	14	18	28	7	6	139	1.1%
Severe	Cardiovascular disorders (htn, anemia)	622	67	47	47	46	39	868	6.8%
Severe	CNS disorders	602	87	65	51	56	50	911	7.14%
Severe	Complicated Malaria	169	8	4	5	5	5	196	1.50%
Severe	Convulsive disorder	231	7	12	5	8	1	264	2.10%
Severe	Diabetes and related complications	216	13	19	26	9	16	299	2.30%
Severe	Musculoskeletal fracture	506	74	41	47	68	61	797	6.20%
Severe	Poisoning	168	17	11	11	5	18	230	1.80%
Severe	Rape	4	0	0	0	0	0	4	0.30%

Severe	Road traffic accidents	1,027	49	76	50	60	58	1,320	10.30%
Moderate	Animal bites / stings	63	6	5	4	8	2	88	0.70%
Moderate	Gastrointestinal disorders (g/e)	817	69	59	58	44	57	1,104	8.60%
Moderate	Respiratory disorders	929	53	50	50	58	43	1,183	9.26%
Mild	Drug and food allergies	14	0	0	0	2	0	16	0.13%
Mild	ENT cases	69	5	11	6	3	1	95	0.74%
Mild	Genito urinary disease	195	18	17	24	14	13	281	2.20%
Mild	Others	932	54	75	88	85	60	1,294	10.10%
TOTAL CASES REPORTED		9,417	718	677	724	646	582	12,764	100%

Communication: As part of the operation, there was a centralised communication centre situated within the governor's office block. It was manned 24 hours by paramedics able to give over-the-phone

first aid instructions to distress callers before an ambulance arrived at the scene of emergency. Table 2 profiles the set-up of the communication centre.

Table 2
Emergency communication centre set-up of Machakos County

Parameters	Details
1. Number of paramedics manning the call centre	5
2. Frequency of calls in 24 hours	Average – 22 Minimum - 19 Maximum -24
3. Total number of distress calls received at the communication control room in a typical month	951 (Min 850 and Max 980)
4. Number (& %) of instances that an ambulance was sent	750 (78.9%; CI 70.8%-83.3%)
5. Number of (& %) instances that an ambulance was not sent	201 (21.1%; C.I. 19.8% - 23.5%)
6. Communication device types	1. 80 pieces of two-way radios (Sony) VHF radio, walk talkies and mobile phones. 2. Safaricom customized emergency no. 999 (code shared with police and fire departments) 3. Call costs are toll-free (i.e. no charges per call to the caller.

Costs of running ambulances: The cost of running ambulances in Machakos County are profiled in Table 3. Staffs salaries (paramedics) were not available due to a clause in the human policy guideline of none disclosure by the County Government. To estimate annual staff salaries, it was taken to account for 49% of total annual cost based on Prinja S. *et al.* 2013 (10).

Equipments involved in running of ambulances accounted for 4.98%, medical consumables 4.78%, equivalent rental space in Machakos town 1.36%, Overheads cost which included insurance, ambulances servicing, fuelling, electricity and water bills 33.5% and IEC (Information, Education and Communication) 6.37% of total annual operation costs.

Table 3
Types of costs associated with running ambulance services in Machakos County

Types of Cost	Monthly Costs	Annually Cost	
	Kshs.(USD)	Amount Kshs. (USD)	% of overall cost
Capital Cost			
Purchase of ambulance	-	185,000,000 (1887755.1)*	-
Operational Costs			
Personnel	2,871,752 (29303.4)	34,461,027 (351643.1)	49.0%
Equipment's/ non- consumables	291,667 (2976.2)	3,500,000 (35714.33)	5.0%
Consumables	280,000 (2857.14)	3,360,000 (34285.7)	4.8%
Space	80,000 (816.3)	960,000 (9795.9)	1.4%
Overheads**	1,963,967 (20040.5)	23,567,600 (240485.7)	33.4%
IEC	373,333 (3809.5)	4,480,000 (45714.2)	6.4%
Total Operational Costs	5,860,719 (59803.25)	70,328,627 (717639.0)	100%

Note: * - this is a onetime payment. Hence not re-current cost.

** - Overheads includes vehicle insurance, ambulances servicing, fuelling, electricity and water bills

Unit costs: The average unit cost per kilometer was at Kshs. 30.9(USD 0.32) with a maximum of Kshs. 33.5(USD 0.34) and a minimum of Kshs. 28.7(USD 0.29) Cost per victim transported by an ambulances was at Kshs. 6,504(USD 66.38).

Table 4
Annual unit cost in kilometers and patients incurred by Machakos ambulance services

Variable	Unit cost in Kshs. (USD)	Determination of unit cost
Cost per kilometer	30,9(USD 0.32)	Total cost of operation/ total average km in a year
Cost per patient transported	6,504(USD 66.38)	Total cost of operation/total patient transported in an year
Net cost per kilometer	30.9(USD 0.32)	Cost net of operation incurred from ambulance services/total km in a year
Net cost per patient transported	6,504(USD 66.38)	Cost net of operation incurred from ambulance service/total number of patients
Maximum unit cost per kilometer	33.5(USD 0.34)	Total cost of operation/ minimum total average km in a year
Minimum unit cost per kilometer	28.7(USD 0.29)	Total cost of operation/ maximum total average km in a year

Depreciation of ambulances: According to insurance policy cover for the County Government of Machakos,

depreciation of ambulances was estimated to be (5% - 10%) per year. Taking the average 7.5% per annum, depreciation of the ambulances was calculated. Therefore, depreciation of a single ambulance was $7.5/100 \times 1,700,000 = \text{Kshs. } 127,500 (\text{USD } 1301)$ per annum a while for 70 ambulances was $7.5/100 \times 119,000,000 = \text{Kshs. } 8,925,000 (\text{USD } 91071.42)$.

Demand and supply barriers: From key informant interview, the key demand (community views) factors were social cultural and health seeking behaviours. The supply (County Government) barriers were transport costs, operational costs and in-efficient signage / mapping direction to the location where victims were to be peaked. Table 5 profiles demands and supplies barriers.

Table 5
Demand and supply transport (ambulance) barriers for ambulance service run by Machakos County

Demand (Community) side	Supply (County Government) side
1. Social cultural factors	1. Transport cost
Traditional beliefs like traditional medicines and witch doctors	Two wheeled vehicles
Communication of directions to the place of emergency e.g. actual road distances not well articulated	Long distances
Language - communication for the condition of the casualty to the paramedics	In some locations dilapidated road surfaces
2. Health seeking behaviours	2. Operational costs
Abuse of the system since its free	Fractuating fuel costs
	Staff costs
3. Political patronage	3. In-efficient signage / mapping direction to the location where the casualties are to be peaked
Political class interferences	
	4. Technical inputs/ vehicle upgrade
	Cost of upgrading the ambulances to advanced life support (ALS)
	5. Motivation of staffs

Technical efficiency: The average cost-efficiency (technical) of the public ambulance transport services was found to be at 90.6% with a confidence interval of 82.7% - 98.2%. This was based on the following variable; Number of casualties transported between January to May 2015; the monthly overheads cost (ambulances only); and consumables. All other variables were held constant in a quadratic equations.

DISCUSSIONS

Victims in need of Emergency obstetric care (EMOC) accounted for 24.7% of all conditions transported, which is consistent with the national focus MOH, 2013 which indicated a high maternal mortality ratio of 488: 100,000 (12). Victims of road traffic accidents was second at 10.3%. In the same period only four cases (0.03%) of rape were transported by ambulances indicating such event being rare or limited disclosure where such event happen within family ties.

Efficient and reliable transport systems often go hand in hand with communication technologies. Effective communication between the community

and the transport operator is particularly important in rural areas where the population is dispersed and demand is low. The rapid spread of mobile telephone technology has increased the prospect for better communications in the referral process for an increasing number of communities which are currently underserved. Machakos County had a well laid infrastructure of communication to the ambulance services that is, a 24/7 hour functioning call centre manned by paramedics, mobile phones, two way radios in all the ambulances as well as walk talkies when the paramedics are out of the ambulance. There was a customised hotline number (999) with partnership with Safaricom received at the call centre free of cost to the callers. This study found that out of 951 emergency calls that were received at the call center, in about 78% instances, an ambulance was dispatched. The rest of the call were either non-critical and with first aid instructions over the telephone, the situation was brought under control. A study carried in Sierra Leone by Samai and Sengeh, 1997 (13), documented that putting an emergency vehicle in the local hospital and a system of communication (first

with motorbikes and then radios) in eight primary health units, resulted in the increase in the number of women from 0.9 to 2.6 per month and reduced mortality rates from 20 to 10 percent among women with obstetrical complications.

Annual cost of running the ambulances in Machakos was Kshs. 70,328,627(USD 717639.05). The results found that staff salaries took the major share of the operating costs at 49%, which was consistent with a study done in India by Prinja S. *et al.* (2013) (10) which found staffs salaries to range between 35- 49% of the total expenditure. Overheads cost accounted for 33% of total annual costs. The county had its ambulance services offices situated at the public office, hence to obtain the cost of space (rent) similar space in the same area were evaluated and found to be at 1.4% of the total annual cost. The average unit cost per kilometer was Kshs. 30.9(USD 0.32) with a maximum of Kshs. 33.5(USD 0.34) and a minimum of Kshs. 28.7(USD 0.29). Cost per victim transported by an ambulances was Kshs. 6,504 (USD 66.37).

From the key informant interview the demand barriers of ambulance services identified were as follows; the community represented the demand side since they were at the receiving end from the county. It was found that social cultural factor was one of the major barrier to the uptake of the ambulance services like beliefs of witch doctor being healers, communication of the directions to the paramedics as well as language barrier due to illiteracy level especially in the rural areas. The second barrier was poor health seeking behaviours whereby some members of the community were making fake calls owing to the fact the calling was free (abuse of the free call service). Political patronage was also found to be a barrier in the uptake of the ambulance services whereby political classes drifted the credibility of the free ambulance services. In addition, adapting ambulance services to social and cultural norms especially the desire for accompanying family members to a referral facility have shown to improve the frequency and use of the services as it leads to trust (14).

The county government supply barriers were; transport cost like cost of upgrading the two wheeled ambulanced to four wheeled ambulanced, long distances covered by the ambulances to get victims and the dilapidated roads in some of locations. Operational costs barriers like fluctuating fuelling costs as well as staff salaries who had to move to different job groups, these findings concur with GOK policy for disaster management, 2009 which found that greatest weakness in running Government ambulances was inadequate operational funds (15). In-efficient signage / mapping direction to the location where victims were to be peaked and cost of upgrading the ambulances to advanced life support (ALS) were other barriers found in Machakos County.

Studies in many countries have found that reducing or eliminating transport costs borne by the communities or family members is necessary to ensure access to much needed services. This study shows that the cost of running and transporting a victim costs the county government an average cost of Kshs, 6,504(USD 66.37). This amount indirectly covers the cost of fuel, motor vehicle insurance, onboard medical consumerable, a proportion of wear and tear, as well as paramedic salary. This would have been the price each victim would had paid if the vehicles were operating under a call-and-pay scenario. In absences of pre-paid insurance schemes, this amount is considerable high for the average rural household earning about a dollar per day. Studies carried out in Burkina Faso and northeast Brazil show that transport costs accounted for 28 percent and 25 percent, respectively, of the total patient costs of using hospital services (14). A study in Bangladesh suggested that transport was the second most expensive item for patients after medicines (16). In rural Sudan, a study showed that about half of the families cited transport costs as the reason for not taking their children with referral need to a hospital (17).

The mean technical efficiency of the public ambulance transport services was found to be 90.6% with a confidence interval of 82.7 - 98.2%. This technical efficiency in Machakos County was higher at (90.6%) compared to Prinja S. *et al.* (2013) in India which was 76.8%. However, this model assumes that each ambulance was operating at 90% efficacy. The figure could be have been lower if each ambulance was analysed individually to determine each vehicle contribution to the data envelopment analysis quadratic model.

In conclusion, Machakos County Governments ambulance services were efficiently operating. However, there was need to embark on creating more public awareness in communication aspects especially in giving directions where victims were to be peaked as well as describing conditions of victims and handling them before arrival of paramedics. All was not met in offering the best Emergency Medical Services (EMS) in Machakos, efforts to be made in upgrading vehicles into four wheeled and obtain a number of Advance life support.

RECOMMENDATIONS

Further studies required to verify exact distance covered by each ambulance as well as determine the cost of life saved as a result of using this ambulance services.

Perception study to patients should be carried out to determine the customer satisfaction levels as a result of using these publicly financed and operated ambulances

LIMITATION

Patients were not interviewed in this study to determine the ability of the population to pay for ambulance services from a public health care point of view as opposed to referral costs.

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