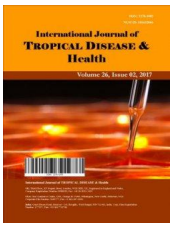

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Operation Assessment on Ambulance Services: A Case Study of Machakos County, Kenya

Wambura Francis Muchiri[1,2*], Karanja Simon Muturi[1], Ngumo James Kariuki[3], Otundo Dennis Orare[4], Chimbevo Lenny Mwagandi[1,5] and Muthuka John Kyalo[1,6]

[1]Institute of Tropical Medicine and Infectious Diseases (ITROMID), College of Health Sciences, Jomo Kenyatta University of Agriculture & Technology, Kenya.
[2]Kenya Medical Training College, Department of Health Education & Promotion, Nyahururu, Kenya.
[3]Center for Public Health Research (CPHR), Department of KEMRI, Kenya.
[4]Institute of Tropical and Infectious Diseases, College of Health Sciences, University of Nairobi, Nairobi, Kenya.
[5]School of Health sciences, Kirinyaga University, Kerugoya, Kenya.
[6]Kenya Medical Training College, Department of Health Education & Promotion, Nairobi, Kenya.

Authors' contributions

This work was carried out in collaboration between all authors. Authors WFM, KSM and NJK designed the study, developed the protocol and managed the literature searches the study. Author WFM performed the data collection of the study. Authors CLM, ODO and MJK performed the statistical analysis and participated in the development of the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

An efficient ambulance services is an integral component of EMS (Emergency Medical services). This paper attempts to establish a cost-efficient ambulance service appropriate for community critical care transport needs in Kenya on basis of data collected in Machakos County. A descriptive

**Corresponding author: E-mail: kanaire@yahoo.com;*

cross-sectional study design was conducted between January and May 2015. Multistage sampling was carried out to recruit household's respondents. The technical efficiency scores were computed using Data Envelopment Analysis (DEA) Programme, version 2.1 (DEAP 2.1). The model was based on two inputs (cost incurred on vehicles and medical consumables) and one output (number of kilometres covered monthly by an ambulance). The household survey results demonstrated that all the residents (100%) were aware of free ambulatory services, 30-39 years 31.5% (95% CI ± 4.55) was the dominant population of which majority had 1- 3 children 66.3% (CI± 4.63). It was reported by the majority (78,3%) that the ambulance services were accessible, available and efficient to those who sought them. Between the periods starting March 2014 to May 2015, a total of 12,674 clients were transported by ambulances from the locations to various tires (levels) of hospitals, Majority 24.7% (95% CI; ± 0.75) were in need of emergency obstetric care (EMOC). The annual operational cost was Kshs. 70,328,627 ($717.639); staff salaries accounted for 49% (95% CI ±0.01) of operational cost, overheads costs at 33.5% (95% CI ±0.01) and 1.3% for renting equivalent operation space. The key demand factors were; social-cultural, health-seeking behaviours and political patronage while supply barriers were; transport costs, operational costs and in-efficient signage. Machakos County Government was operating at an average technical efficiency of 90.6% (95% CI ±7.9). In conclusion, Machakos County ambulance services were operating efficiently (technically).

Keywords: Ambulance services; knowledge; accessibility; cost-efficient; Kenya.

1. INTRODUCTION

Emergency Medical Service (EMS) is activated at the community level when someone identifies a perceived emergency condition, which needs urgent care. This ideally triggers a cascade of events resulting in a timely response of expertise, resources, and service directed to patient stabilization and/or safe emergency patient transportation to the nearest appropriate facility [1,2,3]. Delivery of efficient emergency medical services (EMS) is critical in reducing mortality and disability rates, some studies have found an important relationship between response time and mortality rate [4]. The current norm in many low- and middle-income countries is, however ironic, to use a private vehicle or a taxi to transport the injured or ill person to the hospital, even when EMS has an active presence in these communities [5]. Inadequate ambulances have also been a major challenge in the developing countries whereby you find a single ambulance needed to cover a large geographical area. This becomes impossible because the infrastructure of these nations is poor leading to the rapid wearing of the ambulance translating to poor performance [2].

Response time performance has been used as an indicator of ambulance service quality for many years. Standards for performance have been in place in England since 1974. These standards specified that 50% of all calls should be responded to within 8 minutes and 95% within 14 minutes in urban services and 19 minutes in rural services [3]. In the United States the Emergency Medical Services states that; 95% of requests should be served within 10 min in urban areas, whereas, in rural areas, they should be served within 30 min [6]. According to statesman (2013) the move towards standardization is now reaching countries without a history of prescriptive codes, such as India, which approved its first national standard for ambulance construction in 2013 [7]. There is currently no official "response time" standards in the South African system. However, response times of fifteen minutes for high-acuity calls in urban areas are considered acceptable, and in rural areas, response times of up to forty minutes for similar calls are not uncommon. In Kenya, there is no documented information about ambulance response time standard. According to Rockefeller Foundation's Information City Dialogues (RFICD) 2013, the Government of Kenya has no coordinated emergency response plan, even though road accidents kill nearly 3,500 Kenyans a year [8]. There are few trained paramedics and fully equipped ambulances, and authorities at all levels do not have emergency response plans.

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 the health referral process [9]. Many households do not have the reliable, suitable, and affordable transport services that are essential for access to care during the critical periods such as when life-threatening conditions

occur either at home or outside environment. It has been argued that emergency access to care is also critical especially in common conditions such as during childbirth-related complications are unpredictable and the majority of births in developing countries continue to take place at home [9]. Various financial, social and institutional factors of supply and demand impose severe constraints on the effectiveness of transport means. Moreover, families in low resource settings often cannot afford the ambulance costs to health facilities [9,10]. Other factors that potentially contribute to the delay in access to emergency care include the family's decision to seek care, the availability of suitable transport, and the perceived availability and quality of health services. This study, therefore, aims at documenting the experiences of operating (technical efficiency) of publicly financed and operated ambulances as part of a community initiative under the primary health care strategy adopted by County Government of Machakos.

2. MATERIALS AND METHODS

The study was conducted in Machakos County; Kenya using a cross-sectional study design with Household heads, Ambulance Fleet Manager, Procurement Officer and Human Resource Manager of Machakos County Emergency Services as the study population. The data was collected using a key informant interview guide; desk review and semi-structured household questionnaires. To determine the cost-efficient (technical efficiency) levels, Data Envelopment Analysis (DEA) version 2.2 (DEAP 2.1) software designed by Coelli was used [11], which measures the relative efficiencies of services with multiple inputs and multiple outputs. The ranges of services offered are called the decision-making units (DMUs). DEA assigns pre-determined weights to the inputs and outputs of a DMU which in return gives it the best possible efficiency. It thus arrives at a weighting of the relative importance of the input and output variables that reflect the emphasis that appears to have been placed on them for that particular DMU. At the same time, though, DEA then gives all the other DMUs the same weights and compares the resulting efficiencies with that for the DMU of focus.

The DEA formula used was;

$$\text{Efficiency}=\frac{outputs}{Inputs}$$

For the key informant's interviews (KIIs), themes based on the various responses from the respondents were constructed. The outputs were used to explain some the demand and supply patterns from the qualitative findings. The household questionnaires data was entered into excel and cleaned by checking for consistency and missing values. The data was later transferred to SPSS (Version 17) where all the variables were coded and checked once again for consistency. The data analysis was largely descriptive with the results displayed in frequency tables and graphs. Cross-tabulations were also done to compare how key demographic variables related to knowledge, access, awareness and quality of the ambulatory services. The interpretation of the data and discussion was systematic whereby all the tables and graphs are explained to give further insights into the data. Ethical clearance to conduct the research was sought from Kenyatta National Hospital/University of Nairobi (KNH/UoN) Ethical Review Committee. Permission/consent to carry out the research in Machakos was sought from the County government of Machakos, Department of health. The research was voluntary and none of the respondents was coerced to take part in it, however the researcher took time to explain to the respondents the importance of the study to them and that their participation was highly appreciated. The respondents were assured that their participation was to be kept confidential and used solely for purpose of research and they will remain anonymous.

3. RESULTS

3.1 Knowledge, Attitude and Perception of the Community on the Machakos County Ambulance Services

3.1.1 The demographic profile of the respondents

Out of 400 respondents, 243 (60.8%) were males while 157 (39.2%) were females. The respondents (31.5%) (95% CI=26.95-36.05) were between ages 30-39 (mean 34.5±2.5 years) with the least being above 60 years at 4.5 % (95% CI=2.47-6.53 2). A total of 333 (83.3%) among 400 respondents were reported to be married with only 8 (2%) reporting to be widows. The respondents had undergone formal education with only 14 (3.5%) reporting not having any kind of formal education. Most of the respondents were Christians 98.5% (95%

CI=97.31-99.69) while the rest were Muslims. The sizes of the families were small having 1-3 children 66.3% (95% CI=61.67-70.93), 4-6 children 15.5% (95% CI=11.95-19.05) and above 6 children at 5.3% (95% CI=3.1-7.5). Most of the respondents 384 (96%) reported that they earned above Kshs. 15,000 (USD. 153) monthly with only 15 reporting earning less than Kshs. 5,000 (USD. 51) (as shown in Table. 1).

3.1.2 Knowledge on ambulances services (Utility)

All the 400 respondents were aware of the ambulance services offered by Machakos County Government. The colour of the ambulances was ranked first as the most distinctive feature of Machakos county ambulances with size being ranked the last (as shown in Table 2).

Radio was the main source of information on products and services offered by the ambulances at 79.3% (95% CI=75.33-83.2), television at 20.5% (95% CI=16.54-24.46) and newspapers at 0.3%(95%CI=-0.24-0.84).

All respondents reported that the ambulatory services offered by the county were free of charge.

Table 1. Demographic characteristics of the respondents

Demographic characteristics	Frequency(n=400)	Percentage [95% C.I.]
Sex of the respondents		
Male	243	60.8 (55.96-65.54)
Female	157	39.2 (34.42-43.98)
Age of the respondents (years)		
18-29	64	16 (12.41-19.5)
30-39	126	31.5 (26.95-36.05)
40-49	107	26.7 (22.36-31.04)
50-59	85	21.3 (17.29-25.31)
≥ 60	18	4.5 (2.47-6.5)
Marital status		
Married	333	83.3 (81.27-85.33)
Single	59	14.8 (11.32-18.28)
Window	8	2.0 (0.63-3.37)
Education level		
No formal education	14	3.5 (2-5.3)
Primary school	40	10.0 (7.06-12.94)
Secondary level	237	59.3 (54.49-64.14)
Tertiary level	109	27.3 (22.93-31.67)
Religion of the respondents		
Christians	394	98.5 (97.31-99.69)
Muslims	6	1.5 (0.31-2.69)
Number of children		
No child	52	13.0 (9.7-16.3)
3-Jan	265	66.3 (61.67-70.93)
6-Apr	62	15.5 (11.95-19.05)
Above 6	21	5.3 (3.1-7.5)
Income in Kshs. (USD)		
<5000(51)	15	3.8 (1.93-5.67)
5000(51)-10000(102)	31	7.8 (5.17-10.43)
10000(102)-15000(153)	70	17.5 (13.78-21.22)
>15000(153)	284	71.0 (66.55-75.45)
Occupation		
Supported	70	17.5 (13.78-21.22)
Business	163	40.8 (35.98-45.62)
Farming	125	31.3 (26.76-35.84)
Formal employment	42	10.5 (7.5-13.5)

Table 2. Distinctive features of Machakos County ambulances

Feature	Responses (respondents ticked all applicable point)	Ranking
Branding	201	2
Colour	241	1
Size	60	4
Type of vehicle	93	3

Table 3. Source of information on products and services offered

Medium	Frequency	Percentage (%)
Radio	317	79.3
Television	82	20.5
Newspaper	1	0.3

3.1.3 Access to the ambulances

Out of 400 respondents, 207 (51.75%) reported that they had not been transported by the county's ambulances; or a member of their family had not been transported by the county's ambulances. Out of the 207 respondents, 166 (80.2%) reported that ambulances were easily accessible, 38 (18.3%) saying that they were not accessible and only 3 (1.4%) giving no opinion. Out of the 193 respondents who had an experience with the ambulance services only 3 reported that they were not accessible with the majority reporting they were easily accessible.

Majority 305 (78.25%) of respondents said they had never encountered a community member complain about the ambulance services. The 95 (21.75%) respondents who reported having encountered a complain mainly was due to poor response time 39 (41%), Inefficient communication 25 (26.3%), poorly stocked ambulances 22 (23.15%), Incompetent paramedics 7 (7.3%) and the least being poor ambulance policies 2 (2.1%).

In the event of an emergency, 89% (95% CI=82.6-89.4) of the respondent reported that Machakos ambulances would arrive at the scene in good time with 8.3% (95% CI=5.6-11) reporting the response time was poor and a minority of 2.8% (95% CI=1.18-4.42) giving no opinion. The opinion of the respondents was that the ambulance services were available to everyone 335 (83.75%) with a minority of 65 (16.25%) reporting otherwise.

When asked if the ambulance service meet the demand of the community, Majority 52.8% (95% CI=47.91-57.69) said they were in agreement, 35.5% (95% CI=30.81-40.19) strongly agreeing with only 1.3% (95% CI=0.19-2.41) giving no opinion to the question (Table. 5).

Table 4. Complains reported about the ambulance services

Complains	Frequency	Percentage (%)
Poor response time	39	41
Inefficient communication	25	26.3
Poor stocked ambulances	22	23.2
Incompetent paramedics	7	7.3
Poor ambulance policies	2	2.1

Table 5. Attainment of community ambulance services demand

	Frequency	Percentage [95% C.I.]
Agree	211	52.8 (47.91-57.69)
Disagree	32	8.0 (5.34-10.66)
No opinion	5	1.3 (0.19-2.41)
Strongly agree	142	35.5 (30.81-40.19)
Strongly disagree	10	2.5 (0.97-4.03)

3.1.4 Awareness on the ambulance services offered

Only 6 (1.5%) respondents reported not being aware of the free ambulance service offered by Machakos County government with the majority 394 (98.5%) being aware of the free services. Out of 400 respondents, 202 (50.5%) reported that ambulance services were affordable with 184 (46%) strongly agreeing, 8 (2%) disagreeing and 6 (1.5%) strongly disagreeing (as Shown in Fig. 1).

There was good uptake on the ambulance services in Machakos County with 187 (46.75%) agreeing and 182 (45.5%) agreeing; 22 (5.5%) disagreeing, 6 (1.5%) strongly disagreeing and only 3 (0.75%) giving no opinion (as shown in Fig. 2).

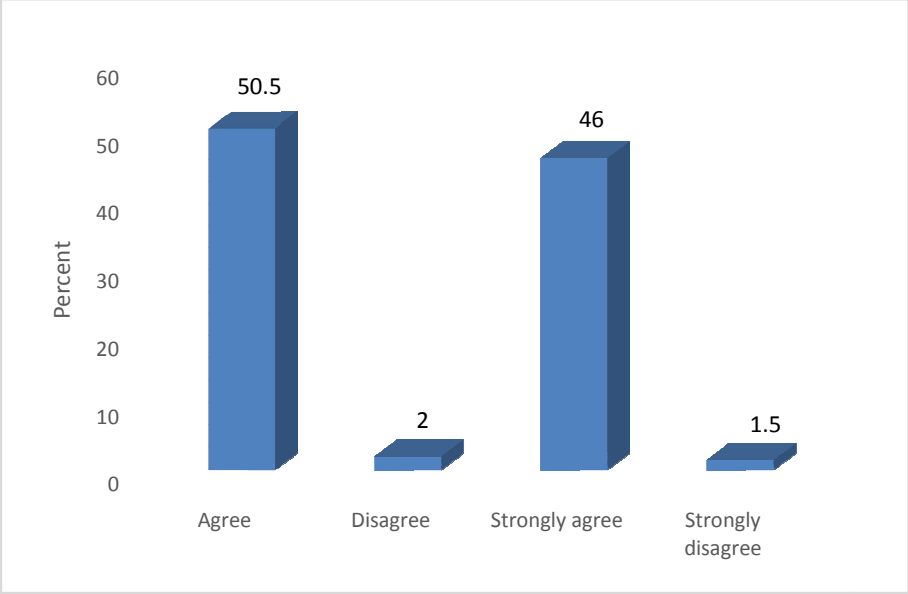

Fig. 1. Affordability of ambulance service

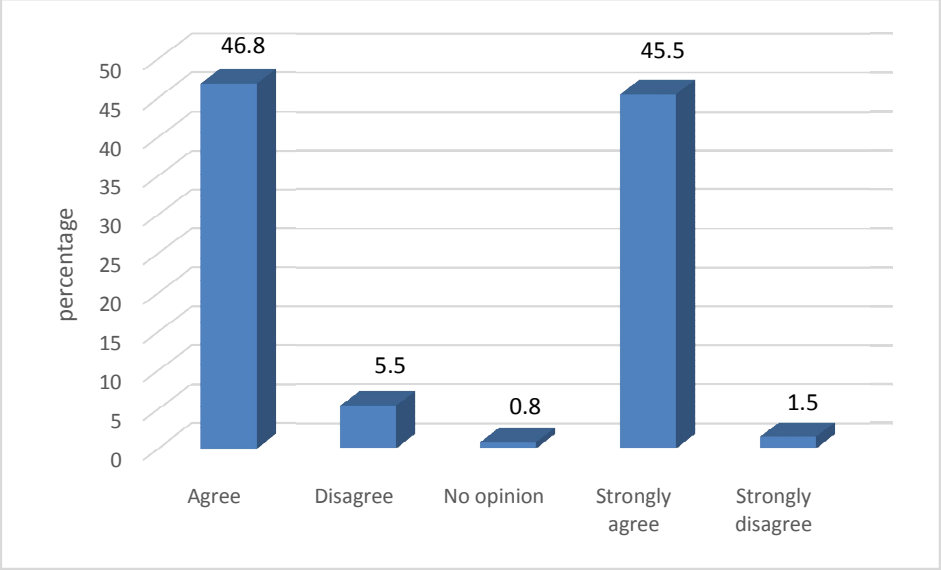

Fig. 2. Uptake of ambulance services offered by Machakos County

3.1.5 Quality of the services

Majority of the respondents (190, n=400) strongly agreed that the quality of ambulance services offered were good with 30 (7.5%) disagreeing and 3 (0.75%) giving no response. Majority 66.3% (95% CI; 61.67-70.93) of the respondents said that the ambulance model offered by the County was efficient, 22.8% (95% CI; 18.69-26.91) strongly agreeing and 1.5% (95% CI; 0.31- 2.69) strongly disagreeing that the model was efficient.

When asked whether the county seeks for community opinion before implementing any new product in the emergency medical services, minority 35 (8.8%) of the respondents strongly disagreed, 75 (18.8%) gave no opinion, 85 (21.3%) disagreed and a majority of the respondents being in agreement (agree 154 and strongly agree 51).

3.1.6 Improvements

Out of 400 respondents, 347 (86.75%) stated that they were satisfied with the ambulance services offered. However, 53 (13.25%) were not satisfied and pointed out area which they felt needed to be improved. The breakdown of those who needed improvement is given in Table 7.

3.1.7 Distribution of cases (clients) transported by ambulances

Between the periods starting March 2014 to May 2015, a total of 12,674 clients were transported by ambulances from locations to the various tires (levels) of hospitals based on the severity of their conditions. Majority of the transported clients 24.7% (95% CI=23.95-25.45) were those in need for emergency obstetric care (EMOC); clients involved in road traffic accidents accounting for 10.3% (95% CI=9.77-10.83); respiratory disorders 9.26% (95% CI=8.76-9.76); gastrointestinal disorders 8.6% (95% CI; 8.11-9.09); and rape victims were least transported at 0.03% (95% CI=0-0.06).

3.1.8 Annual costs for running ambulance services

The cost of running ambulances in Machakos County was as follow; Staff salaries (paramedics) was not available due to a clause in human policy guideline of none disclosure by the County Government. To estimate annual staff salaries, it was taken to account for 49%(95% CI=48.99-49.01) of total annual cost based on a similar study carried out in India by Prinja S. et al *[12]*. Equipment 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, fueling, electricity and water bills 33.5% (95% CI=33.49-33.51) and IEC (Information, Education and Communication) 6.37% (95% CI=6.36-6.38) of total annual operation costs.

3.2 Unit Cost Estimates Incurred by the County

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 client transported by an ambulance was Kshs. 6,504(USD 66.38).

Table 6. Responses on County seeking community opinion before implementing a new product

Response	Frequency	Percentage [95% C.I.]
Agree	154	38.5 (33.73-43.27)
Disagree	85	21.3 (17.29-25.31)
No opinion	75	18.8 (14.97-22.63)
Strongly agree	51	12.8 (9.53-1607)
Strongly disagree	35	8.8 (6.02-11.58)

Table 7. Responses on areas which needed improvement

Areas of improvements	Ranking	Responses (respondents ticked all applicable point)
Upgrading their vehicles	5	15
Equipping their ambulance well	6	14
Improve on their communication channels	2	49
Standardize their response time	3	38
Increase the number of ambulances	1	53
Mass campaign to enlighten the public	4	37

Table 8. Distribution of the various cases (clients) transported by ambulances over a period of 15 months

Types of Cases	Number of cases reported in 15 months	Mean of cases per month
EMOC (Deliveries and its complications)	3,153	210.2
Alcoholic coma /intoxication	169	11.27
Assault cases	238	15.87
Burns	115	7.67
Cancers	139	9.27
Cardiovascular disorders (htn, anaemia)	868	57.87
CNS disorders	911	61.4
Complicated Malaria	196	12.4
Convulsive disorder	264	17.6
Diabetes and related complications	299	19.93
Musculoskeletal fracture	797	53.8
Poisoning	230	15.33
Rape	4	0.27
Road traffic accidents	1,320	88
Animal bites /stings	88	5.87
Gastrointestinal disorders (g/e)	1,104	73.6
Respiratory disorders	1,183	78.87
Drug and food allergies	16	1.07
ENT cases	95	6.33
Genito urinary disease	281	18.73
Others	1,294	86.27

Table 9. Types of costs associated with running ambulance services in Machakos County

Types of Costs	Monthly Costs	Amount	Annually Cost
Capital Cost	**Kshs. (USD)**	**Kshs. (USD)**	**% of overall cost (95% C.I)**
Purchase of ambulance	-	125,000,000 (1275510.2)*	-
Operational Costs			
Personnel	2,871 ,752 -29303.4	34,461,027 -351643.1	49.0% (±0.01)
Equipment's/ non-consumables	291,667 -2976.2	3,500,000 -35714.33	5.0% (±0.01)
Consumables	280,000 -2857.14	3,360,000 -34285.7	4.80%
Space	80,000 -816.3	960,000 -9795.9	1.40%
Overheads**	1,963,967 -20040.5	23,567,600 -240485.7	33.4% (±0.01)
IEC	373,333 -3809.5	4,480,000 -45714.2	6.4% (±0.01)
Total Operational Costs	5,860,719 -59803.3	70,328,627 -717639	100%

*Note: * - this is a onetime payment. Hence not re-current cost. **- Overheads includes vehicle insurance, ambulances servicing, fueling, electricity and water bills*

3.3 Demand and Supply Transport Barriers of Public Healthcare Provider in Machakos County

From key informant interview, key demand (community) factors were social cultural, health seeking behaviors and political patronage. Majority of the locals believed in the healing power of witch doctors whereby they associated illness as a bad omen which had to be undone. Most of the locals in the interior locations were not educated hence most of the time used the

Table 10. Demand and supply transport (ambulance) barriers for ambulance services run by Machakos County

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

mother tongue which was a challenge to the paramedics. The supply (County Government) barriers were transport costs, operational costs, in-efficient signage / mapping direction to the location where the victim were to be peaked and technical output/ambulance upgrade (Table 10).

3.3.1 Cost-efficient analysis for machakos county ambulance services

It was found that Machakos County Government was operating at an average technical efficiency of 90.6% (95% CI 82.7-98.2). This was based on the following variable; Number of clients transported between January to May 2015; the monthly overheads cost (ambulances only); and medical consumables. All other variables were held constant in a quadratic equation.

4. DISCUSSION

An effective Emergency Medical Services (EMS) is the main goal of all Ministries of health around the world. However, many developing countries have a long way to go before developing an integrated, efficient, and functional pre-hospital care. Machakos County being in Kenya a developing country shares the same challenges but has been on a strategic plan trying to improve its ambulance services to be the best in the region. More than half (243, n=400) of the household respondents were males. Majority of the respondents 31.5% (95% CI =26.95-36.05) were between ages 30-39 years, this demonstrated that the county had a young and vibrant population with most families having 1-3 children 66.3% (95% CI=61.67-70.93). The results showed that most of the respondents had undergone formal education with only 14 (n=400) not having any kind of formal education. All the respondents were aware of the free ambulatory services offered by their county government. The colour of the ambulance was the most distinctive feature as radio was the main source of information on products and services offered by the ambulances. Generally, ambulances were easily accessible to those who sought them with only (3, n=193) claiming they were not accessible this results were in tandem with Morgan et al. [13] findings in a similar study in Kenya which found ambulance services to be easily accessible. In the event of an emergency 89% (95% CI=82.6-89.4) of the respondent said that Machakos ambulances would arrive at the scene in good time with 8.3% (95% CI=5.611) reporting the response time was poor this concur with Mould et al. [2] study in Ghana findings which found poor ambulance response time due to poor infrastructure and communication.

Majority 66.3% (95% CI=61.67-70.93) of the respondents said that the ambulance model offered by the county was efficient this was in agreement with the results obtained from the Data Envelopment Analysis, which found a technical efficiency of 90.6%. The County

Government of Machakos had 70 operating ambulances (Basic life support), which had been in operational between the periods starting March 2014 to May 2015. In the period a total of 12,674 clients were transported by ambulances from the locations to the various tires of hospitals. Clients in need of emergency obstetric care (EMOC) accounted for 24.7% (95% CI =23.95-25.45) of all conditions transported, this was consistent with the national focus MOH, 2014 which indicated a high maternal mortality ratio of 488: 100,000 [14]. Victims of road traffic accidents was second at 10.3% (95% CI=9.77-10.83). In the same period only 4 cases (0.03%) of rape were transported by ambulances indicating such event being rare or limited disclosure where such event happens within family ties. Annual cost of running the ambulances was Kshs. 70,328,627 (USD. 717,639.0). The results found that staff salaries took the major share of the operating costs at 49% (95% CI ±0.01), which was consistent with a study done in India by Prinja S. et al. 2013 [12] which found staff's salaries to range between 35-49% of the total expenditure. Overheads cost accounted for 33% (95% CI =32.99-33.01) of total annual costs. The county had its ambulances services offices situated at the public office, hence to obtain the cost of space (rent) similar space in the same area were evaluated and was found to be at 1.4% of the total annual cost.

To identify demand and supply barriers of county financed ambulance services a key informant interview was carried-out with the fleet manger being the respondent. 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 behaviors whereby some members of the community were making fake calls owing to the fact that 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 [15]. The county government (supply) barriers was transport cost; cost of upgrading the two wheeled ambulanced to four wheeled ambulances; long distances covered by the ambulances to get clients; and the dilapidated roads in some of locations. Operational costs barriers like fluctuating fueling costs as well as staff salaries who have to rise to different job groups. These findings concur with GOK policy for disaster management, 2009 whose findings was that the greatest weakness in running government ambulances was inadequate operational funds [16]. In-efficient signage / mapping direction to the location where clients were to be peaked and technical inputs/ vehicle upgrade, 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 cost the county government an average of Kshs. 6,504 per patient. This amount indirectly covers the cost of fuel, motor vehicle insurance, onboard medical consumables, a proportion of wear and tear, as well as paramedic salary. This would have been the price each victim would have paid if the vehicles were operating under a call-and-pay scenario. In absences of pre-paid insurance schemes, this amount was 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 [17]. A study in Bangladesh suggested that transport was the second most expensive item for patients after medicines [17]. 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 [18]. The average technical efficiency of the Machakos County ambulance services was found to be 90.6% (95% CI=82.7-98.2). This was based on the following variables; Number of clients transported between January to May 2015; the monthly overheads cost (ambulances only) and medical consumables. This technical efficiency found in Machakos County was higher at 90.6% (95% CI= 82.7-98.2) compared to Prinja S. et al. study in India which was at 76.8% [12]. However, this model assumes that each ambulance was operating at 90% efficacy. The figure could have been lower if each ambulance

was analyzed individually and determine each vehicle contribution to the DEA quadratic model.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The results from the household survey demonstrated that residents were aware of the free ambulatory services being offered by the county government. The population was majorly made up of individuals of ages 30-39 (mean: 34.5±2.5) years 31.5% (95% CI=26.95-36.05) of which majority had 1- 3 children. However, the population is mainly grouped under formal education category. The majority of respondent reported that the ambulance services were accessible, available and efficient to those who sought them. However, they pinpointed areas, which needed improvement for upgrading the ambulances, training paramedics, upgrading the ambulances as well as involving the community when developing new products and services. Moreover, the study highlighting the costs involved in running of the ambulance services in Machakos County were; staff salaries accounting for 49% (95% CI=48.99-49.01), medical consumables, equivalent rental space in Machakos town, overhead cost which included insurance, ambulances servicing, fueling, electricity and water bills and IEC (Information, Education and Communication) 6.37% (95% CI=6.36-6.38) of total annual operation costs. The key demand barriers identified by the study were; social cultural factors, health seeking behaviors and political patronage while the supply barriers were; transport costs, operational costs, in-efficient signage / mapping direction to the location where the victim were to be peaked, technical inputs and motivation of staffs. The present study established that Machakos County Government ambulance services were operating efficiently with an average technical efficiency of 90.6% (95% CI=82.7-98.2).

5.2 Recommendations

From the demand and supply barriers identified I recommend the Machakos county government to embark on creating massive awareness to all the residents on behavior change and accepting the services offered. The County also has two wheeled ambulances, given the terrain and most of the roads being all weather roads I recommend the upgrade of the ambulance to four-wheel drive. The County Government should involve the community when developing new products and services to incorporate their inputs. Further studies required to verify the exact distance covered by each ambulance as well as determine the cost of life saved as a result of using this ambulance services.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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