

OPERATION ASSESSMENT ON AMBULANCE SERVICES: A CASE STUDY OF MACHAKOS COUNTY, KENYA

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 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 kilometers 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 $\pm$ 4.55) was the dominant population of which majority had 1- 3 children 66.3% (CI $\pm$ 4.63). It was reported by 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 tiers (levels) of hospitals, Majority 24.7% (95% CI; $\pm$ 0.75) were in need of emergency obstetric care (EMOC). Annual operational cost was Kshs. 70,328,627 (\$717.639); staff salaries accounted for 49% (95% CI $\pm$ 0.01) of operational cost, overheads costs at 33.5% (95% CI $\pm$ 0.01) and 1.3% for renting equivalent operation space. The key demand factors were; social cultural, health seeking behaviors 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 $\pm$ 7.9). In conclusion, Machakos County ambulance services were operating efficiently (technically).

KEY WORDS: Ambulance services, Knowledge, Accessibility, Cost-Efficient, Kenya

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 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 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 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 are 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 as 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

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 reflects 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;

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

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.

RESULTS

Knowledge, attitude and perception of the community on the Machakos County ambulance services

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).

Table 1: Demographic characteristics of the respondents

Demographic characteristics	Frequency(n=400)	Percentage [95% C.I.]
Sex of the respondents		
M a l e	243	60.8 (55.96-65.54)
F e m a l e	157	39.2 (34.42-43.98)

Age of the respondents (years)									
1	8	-	2	9	6		4	16	(12.41 - 19.5)
3	0	-	3	9	1	2	6	31.5	(26.95 - 36.05)
4	0	-	4	9	1	0	7	26.7	(22.36 - 31.04)
5	0	-	5	9	8		5	21.3	(17.29 - 25.31)
≥			6	0	1		8	4.5	(2.47 - 6.5)
M a r r i e d									
M	a	r	r	i	e	d	3	3	3 83.3 (81.27-85.33)
S	i	n	g	l	e		5	9	14.8 (11.32-18.28)
Window							8	2.0	(0.63 - 3.37)
E d u c a t i o n l e v e l									
No	f	o	r	m	a	l	e	d	u
Primary	s	c	h	o	o	l	4	0	10.0 (7.06-12.94)
Secondary							2	3	7 59.3 (54.49-64.14)
Tertiary							1	0	9 27.3 (22.93-31.67)
Religion of the respondents									
C	h	r	i	s	t	i	a	n	s
M	u	s	l	i	m	s	6	4	98.5 (97.31-99.69)
									1.5 (0.31 - 2.69)
N u m b e r o f c h i l d r e n									
N	o		c	h	i	l	d	5	2
1			-				3	2	6 5 66.3 (61.67-70.93)
4			-				6	6	2 15.5 (11.95-19.05)
A	b	o	v	e			6	2	1 5.3 (3.1 - 7.5)
I n c o m e i n K s h s . (U S D)									
<	5	0	0	0	(	5	1	)	1
5000	(51)	-	10000	(102)					3
10000	(102)	-	15000	(153)					7
>	1	5	0	0	0	(	1	5	3
							2	8	4 71.0 (66.55-75.45)
O c c u p a t i o n									
S	u	p	p	o	r	t	e	d	7
B	u	s	i	n	e	s	s	1	6
F	a	r	m	i	n	g			2
Formal									4
employment									2 10.5 (7.5 - 13.5)

130

131 Knowledge on ambulances services (Utility)

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

135 Table 2: Distinctive features of Machakos County ambulances

F e a t u r e	Responses (respondents ticked all applicable point)		R a n k i n g
B r a n d i n g	2	0	1
C o l o u r	2	4	1
S i z e	6	0	4
Type of vehicle	9	3	3

136

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).

Table 3: Source of information on products and services offered

M e d i u m	F r e q u e n c y	Percentage (%)
R a d i o	3 1 7 7 9 . 3	
T e l e v i s i o n	8 2 2 0 . 5	
N e w s p a p e r	1 0 . 3	

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

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 on 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%), poor stocked ambulances 22 (23.15%), Incompetent paramedics 7 (7.3%) and the least being poor ambulance policies 2 (2.1%).

Table 4: Complains reported about the ambulance services

C o m p l a i n s	f r e q u e n c y	P e r c e n t a g e (%)			
Poor response time	3	9	4		1
Inefficient communication	2	5	2	6	3
Poor stocked ambulances	2	2	2	3	2
Incompetent paramedics	7		7		3
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 5: Attainment of community ambulance services demand

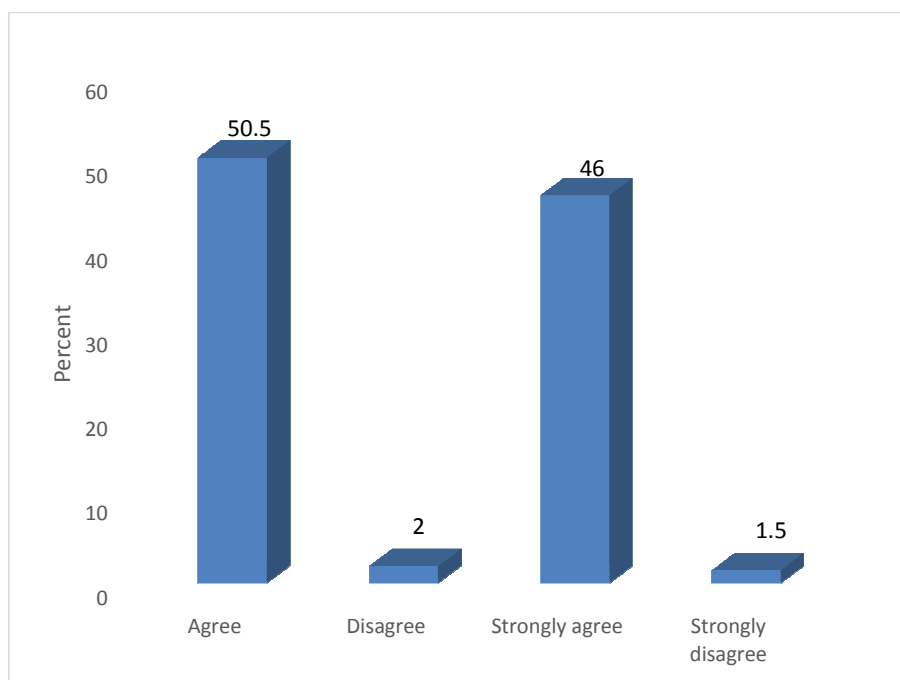
F r e q u e n c y	P e r c e n t a g e [95% C.I.]
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A g r e e	2	1	1	52.8 (47.91-57.69)
D i s a g r e e	3		2	8.0 (5.34-10.66)
N o o p i n i o n		5		1.3 (0.19-2.41)
S t r o n g l y a g r e e	1	4	2	35.5 (30.81-40.19)
S t r o n g l y d i s a g r e e	1		0	2.5 (0.97-4.03)

168

169 **Awareness on the ambulance services offered**

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



175

176 **Figure 1: Affordability of ambulance service**

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

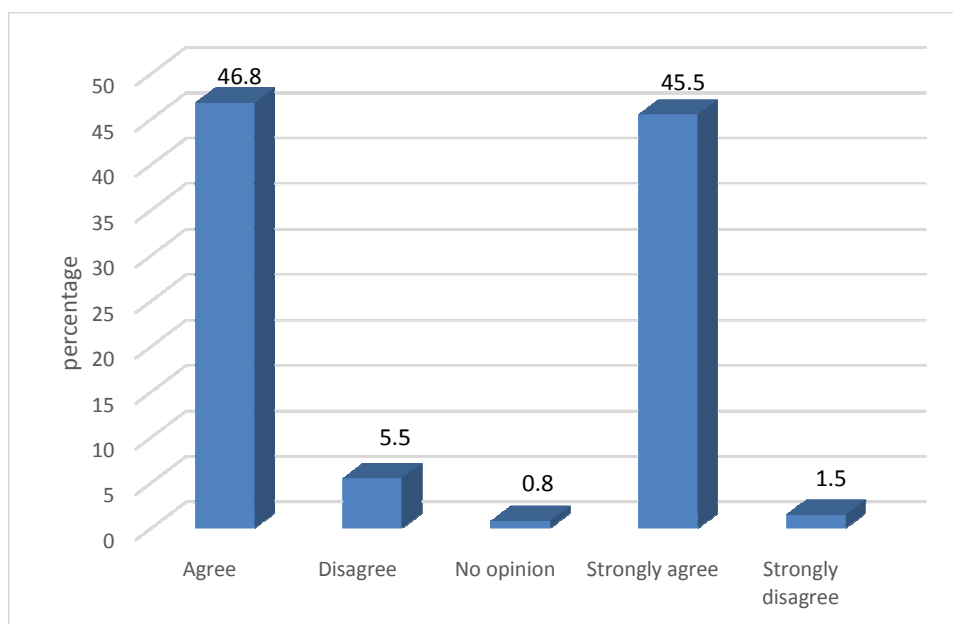


Figure 2: Uptake of ambulance services offered by Machakos County

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).

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 (9.53-16.07)
Strongly disagree	35	8.8 (6.02-11.58)

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.

200 **Table 7: Responses on areas which needed improvement**

A r e a s o f i m p r o v e m e n t s	R a n k i n g	Responses (respondents ticked all applicable point)	
U p g r a d i n g t h e i r v e h i c l e s	5	1	5
E q u i p p i n g t h e i r a m b u l a n c e w e l l	6	1	4
I m p r o v e o n t h e i r c o m m u n i c a t i o n c h a n n e l s	2	4	9
S t a n d a r d i z e t h e i r r e s p o n s e t i m e	3	3	8
I n c r e a s e t h e n u m b e r o f a m b u l a n c e s	1	5	3
M a s s c a m p a i g n t o e n l i g h t e n t h e p u b l i c	4	3	7

201

202 **Distribution of cases (clients) transported by ambulances**

203 Between the periods starting March 2014 to May 2015, a total of 12,674 clients were
 204 transported by ambulances from locations to the various tiers (levels) of hospitals based on
 205 the severity of their conditions. Majority of the transported clients 24.7% (95% CI=23.95-
 206 25.45) were those in need for emergency obstetric care (EMOC); clients involved in road
 207 traffic accidents accounting for 10.3% (95% CI=9.77-10.83); respiratory disorders 9.26% (95%
 208 CI=8.76-9.76); gastrointestinal disorders 8.6% (95% CI; 8.11-9.09); and rape victims were least
 209 transported at 0.03% (95% CI=0-0.06).

210 **Table 8: Distribution of the various cases (clients) transported by ambulances over a period of**
 211 **15 months**

T y p e s o f C a s e s	Number of cases reported in 15 months				Mean of cases per month					
EMOC (Deliveries and its complications)	3	,	1	5	3	2	1	0	.	2 0
Alcoholic coma /intoxication	1		6		9	1	1	.	2	7
A s s a u l t c a s e s	2		3		8	1	5	.	8	7
B u r n s	1		1		5	7	.	6		7
C a n c e r s	1		3		9	9	.	2		7
Cardiovascular disorders (htn, anaemia)	8		6		8	5	7	.	8	7
C N S d i s o r d e r s	9		1		1	6	1	.	4	0
C o m p l i c a t e d M a l a r i a	1		9		6	1	2	.	4	0
C o n v u l s i v e d i s o r d e r	2		6		4	1	7	.	6	0
Diabetes and related complications	2		9		9	1	9	.	9	3
Musculoskeletal fracture	7		9		7	5	3	.	8	0
P o i s o n i n g	2		3		0	1	5	.	3	3
R a p e			4		0		.	2		7
R o a d t r a f f i c a c c i d e n t s	1	,	3	2	0	8	8	.	0	0
A n i m a l b i t e s / s t i n g s	8				8	5	.	8		7
Gastrointestinal disorders (g/e)	1	,	1	0	4	7	3	.	6	0
R e s p i r a t o r y d i s o r d e r s	1	,	1	8	3	7	8	.	8	7
D r u g a n d f o o d a l l e r g i e s	1				6	1	.	0		7
E N T c a s e s	9				5	6	.	3		3
G e n i t o u r i n a r y d i s e a s e	2		8		1	1	8	.	7	3
O t h e r s	1	,	2	9	4	8	6	.	2	7

212

213 **Annual costs for running ambulance services**

214 The cost of running ambulances in Machakos County was as follow; Staff salaries
 215 (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.

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

T y p e s o f C o s t s	Monthly Costs	A m o u n t	A n n u a l l y	C o s t
C a p i t a l C o s t	Kshs. (USD)	Kshs. (USD)	% of overall cost (95% C.I)	
Purchase of ambulance	-	125,000,000 (1275510.2)*	-	
Operational Costs				
P e r s o n n e l	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)
C o n s u m a b l e s	280,000 (2857.14)	3,360,000 (34285.7)	4.8 %	
S p a c e	80,000 (816.3)	960,000 (9795.9)	1.4 %	
O v e r h e a d s * *	1,963,967 (20040.5)	23,567,600 (240485.7)	33.4 %	(± 0.01)
I E C	373,333 (3809.5)	4,480,000 (45714.2)	6.4 %	(± 0.01)
Total Operational Costs	5,860,719 (59803.25)	70,328,627 (717639.0)	100.0 %	

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

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).

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 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).

239

240 **Table 10: Demand and supply transport (ambulance) barriers for ambulance services run**
 241 **by Machakos County**

Demand (Community) side		Supply (County Government) side	
1. Social cultural factors	• Traditional beliefs like traditional medicines and witch doct • Communication of directions to the place of emergency e.g. actual road distances not well articula • Language - communication for the condition of the casualty to the paramed	1. Transport cost	• Two wheeled vehicle • Long distance • In some locations dilapidated road surface
2. Health seeking behaviors	• Abuse of the system since its fr	2. Operational costs	• Fractuating fuel cost • Staff cost
3. Political patronage	• Political class interference	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 (AL
		5. Motivation of staffs	

242

243 **Cost-efficient analysis for Machakos County ambulance services**

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

249 **DISCUSSION**

250 An effective Emergency Medical Services (EMS) is the main goal of all Ministries of health
 251 around the world. However, many developing countries have a long way to go before
 252 developing an integrated, efficient, and functional pre-hospital care. Machakos County
 253 being in Kenya a developing country shares the same challenges but has been on a strategic
 254 plan trying to improve its ambulance services to be the best in the region. More than half
 255 (243, n=400) of the household respondents were males. Majority of the respondents 31.5%
 256 (95% CI =26.95-36.05) were between ages 30-39 years, this demonstrated that the county had
 257 a young and vibrant population with most families having 1-3 children 66.3% (95%
 258 CI=61.67-70.93). The results showed that most of the respondents had undergone formal
 259 education with only 14 (n=400) not having any kind of formal education. All the
 260 respondents were aware of the free ambulatory services offered by their county government.
 261 The colour of the ambulance was the most distinctive feature as radio was the main source
 262 of information on products and services offered by the ambulances. Generally, ambulances
 263 were easily accessible to those who sought them with only (3, n=193) claiming they were not
 264 accessible this results were in tandem with Morgan et al. [13] findings in a similar study in
 265 Kenya which found ambulance services to be easily accessible. In the event of an emergency
 266 89% (95% CI=82.6-89.4) of the respondent said that Machakos ambulances would arrive at
 267 the scene in good time with 8.3% (95% CI=5.611) reporting the response time was poor this
 268 concur with Mould et al. [2] study in Ghana findings which found poor ambulance response
 269 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 $\pm$ 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.

CONCLUSION AND RECOMMENDATIONS

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).

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.

REFERENCES

1. Kobusingye OC, Hyder AA, Bishai D, Joshipura M, Hicks ER, Mock C. Emergency medical services. In: Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M,

- Evans DB, et al., editors. Disease control priorities in developing countries. 2nd ed. Washington (DC): WorldBank; 2006. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK11744/>
2. Mould-Millman NK, Naidoo R, de Vries S, Stein C, Wallis LA. AFEM Consensus Conference, 2013. AFEM Out-of-Hospital Emergency Care Workgroup Consensus Paper: advancing out of hospital emergency care in Africa-advocacy and development. *Afr J Emerg Med*. 2014. Vol. 4(2): pp90-95.
3. Sasser S, Keller mann AL, Lormand JD. Prehospital trauma care systems. World Health Organization; Geneva. 2005. Available from http://www.who.int/violence_injury_prevention/publications/services/04_07_2005/en/
4. R. Sánchez-Mangas A, García-Ferrrer A, de Juan A, Arroyo AM. "The probability of death in road traffic accidents. How important is a quick medical response?". *Accid. Anal. Prev*. 2010; 42(4): 1048- 1056.
5. Tiska MA, Adu-Ampofo M, Boakye G, Tuuli L, Mock CN. A model of prehospital trauma training for lay persons devised in Africa. 2004. *Emerg Med J*. 2004; 21 (2): 237-239.
6. Ball G, Lin LF. "A reliability model applied to emergency service vehicle location," *Oper. Res*. 1993; 41 (1) 18-36.
7. "Ministry gives its nod to national ambulance code". *The Statesman*. 2013-06-07 "EMS systems in South Africa, <http://www.ncbi.nlm.nih.gov/pubmed/15680521>, Accessed 23June 2014.
8. Rockefeller Foundation's Informal City dialogues, Aug 6, 2013. <http://nextcity.org/informalcity/entry/help-kenyans-tweet-their-emergencies-and-ambulances-arrive-within-minutes>
9. Josiah B, Myntti D, Cynthia, and Antoine A. "The Three Delays as a Framework for examining maternal mortality in Haiti." *Social Science & Medicine*. 1998; 46 (8): 981-993.
10. Kobusingye, OC, Adnan AH, David B, Eduardo RC, Charles M, Manjul J. "Emergency medical systems in low-and middle-income countries: recommendations for action." *Bulletin of the World Health Organization*. 2005; 83(8): 79-87.
11. Coelli TJ. *A guide to DEAP Version 2.1: A data envelopment analysis (Computer) Programme*. University of New England, Department of Econometrics. CEPA Working Paper 1996: 8/96.
12. Shankar P, Neha M, Arun K, Manmeet K, Gursimer J& Rajesh K. 'Cost & efficiency evaluation of a publicly financed & publicly delivered referral transport service model in three districts of Haryana State, India'. *Indian J Med Res*. 2013; 138: 1003-1011.
13. Broccoli MC, Calvillo EJB, Skog AP, Wachira B, Wallis LA. Perceptions of emergency care in Kenyan communities lacking access to formalised emergency medical systems: a qualitative study. *BMJ Open*. 2015; 5: doi: 10.1136/bmjopen-2015-009208
14. Ministry of Health "Maternal and new born Health care in Kenya". 2014. <http://www.healthpolicyproject.com/kenya>, Accessed May 23rd.
15. Krasovec, K. "Auxiliary technologies related to transport and communication for obstetric emergencies." *International Journal of Gynecology and Obstetrics*. 2004; 85 (Suppl) 1: S14 - S23.
16. Government of Kenya (GOK). National Policy for Disaster Management in Kenya, march 2009; page 42.
17. Ensor T, Cooper S. Overcoming Barriers to Health Service Access and Influencing the Demand Side Through Purchasing/World Bank publications, please contact the HNP Advisory Services. 2004. (healthpop@worldbank.org).

- 417 18. Mohammed Al, Fadil SH, Simon N, Bustreo, F, Shadoul A, Suzanne F. "Integrated
418 management of childhood illnesses strategy: compliance with referral and follow-up
419 recommendations in Gezira State, Sudan/Bulletin of the World Health Organization:
420 the International Journal of Public Health. 2003; 81(10): 708-716