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Research Article

Cost-Effective Analysis of a Mobile Dental Van in Delivering Primary Oral Health Care among Adopted Schools of a Dental College, Bangalore–a Retrospective Study

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Abstract

Background: Oral diseases remain one of the major public health challenges in India. Mobile dental services may be used as alternatives to supplement the standard care in order to reach underserved populations in several countries. However, not enough research has been conducted on school children. Hence, this paper aimed to evaluate the cost-effectiveness (where cost is expressed in monetary units and results in non-monetary units) of a mobile dental vehicle (MDV) in delivering primary oral health care among adopted schools of a dental college in Bengaluru.
Methods: This retrospective population-based study was conducted among adopted children of the age group of 4–15 years in Bengaluru. The data were collected from the college camp out-patient register over three academic years of 2017-18, 2018-19, and 2019-20 in December 2020. Cost-effectiveness was calculated utilizing the formula total cost (direct+indirect) of service provision with the total number of the patients who used the services in the same period. Statistical tests unpaired student t-test, ANOVA, Tukey's post hoc test, and all the statistical tests were set with a level of significance ($P<0.1$), which was conducted using the statistical package SPSS version 19.0.
Results: A total of 14,806 patients and 75,421 teeth were treated in mobile dental vehicle. The cost for each patient was around 259.0/- rupees and for each tooth, around 51.3/-rupees. Around 2686 teeth were benefitted from the use of a portable dental chair. Therefore, the cost of treating each tooth was around 12.3/- rupees. The mean difference in the number of the treated patients was found to be significantly decreasing.
Conclusion: We conducted the current study to demonstrate the costs of providing primary oral health care among adopted schools. Mobile dental vehicle and the portable dental chair were found to be cost-effective in delivering primary oral health care.

Keywords: Cost-effectiveness, Schools, Children, Mobile dental vehicle, Portable dental chair

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1. Introduction

Oral diseases remain one of the major public health challenges in India. The National oral health survey and fluoride mapping (2002-2003) reported an increase in the prevalence of oral diseases in the country (1).

The increase in the prevalence of oral diseases in the country is mainly due to the rising disparities among the dentist patient population in rural areas, urban slums, and school children who represent the major bulk of the underserved population (1, 2).

This is attributed to the lack of awareness on etiological factors of oral diseases and methods for preventing and controlling them, poor oral hygiene practices, lack of access to even the basic dental services, high levels of deleterious habits like smoking and use of smokeless tobacco, which have been proven to be risk factors for periodontal diseases and oral cancer, lack of affordability to seek sophisticated dental services through private dental practitioners, and lack of perception of the fact that teeth are worth saving (3-6).

The worldwide urban-rural disparities in oral health care are significant. A disparity was noted in the distribution of the population between rural and urban areas in India. The urban population was estimated to be 377.1 million (31.2%) and the rural population was 833.1 million (68.8%; 11, 12). Children below the age of 18 constitute about 40% of the population. Approximately 23.5% of the urban population resides in urban slums (2, 6).

Mobile dental services may solve the disparity in the dentist population ratio and has also been used as alternatives to supplement the standard care to reach underserved populations in numerous countries. They are cost-efficient and highly successful in improving people's access to dental services (2, 7-9).

To determine the success of any program, health economic evaluation is essential, particularly in the era of the growing development of new health interventions, to improve the health of people and the healthcare system. Economic evaluation could be classified into four main types: cost-benefit analysis, cost-utility analysis, cost-minimization analysis, and cost-effective analysis. This paper utilized cost-effective analysis in which costs are expressed in monetary units and results in non-monetary units to determine the success of the Mobile dental vehicle (MDV; 4, 5).

There is limited literature concerning the use of MDVs, specifically among schools and targeting school children. However, most dental institutions conduct camps in schools focusing on school children, which is usually a day-long visit to rural or remote places or school setting for the provision of services like preventive care, curative care, screening for diseases, and health education among different communities (9-11).

Health economics plays an important part in the evaluation of health and healthcare interventions (12, 13). Hence, this paper aimed to evaluate the cost-effectiveness of a mobile dental vehicle in delivering primary oral health care among adopted schools of a Dental College in Bangalore. We conducted this paper to compare the cost-effectiveness over three academic years and to compare the cost-effectiveness of the mobile dental vehicle and a portable dental chair in providing primary oral health care.

2. Materials and Methods

The present study was a retrospective, population-based study, conducted in December 2020, among adopted school children aged 4–15 years, in Bengaluru. The data were collected from the out-patient camp register of the department of public health dentistry for the three academic years of 2017-18, 2018-19, and 2019-20. A total of 20,820 children were screened in the MDV over three years. We adopted a convenience sampling method and included data from all the adopted school benefitted with MDV since the purchase of new MDV by the dental college.

However, the data from screening camps, and schools not adopted by the dental college were excluded. School children, their parents, and teachers were given prior intimation about the dental camps that were held using MDV and consent form was obtained from the parents.

The cost-effectiveness ratio was calculated based on

(a) input expenses, cost of purchase of MDV, and

(b) output, the number of patients benefited

● The expenses considered in the present study were further divided into

(1) Direct cost, included the capital cost of buying the van,

(2) Indirect cost, included the transportation of portable units to the campsite, cost of dental materials (Glass Ionomer Cement - GIC, Local anaesthesia) used while performing various procedures, allowances paid to personnel operating the MDV and cost of fuel per school dental camp was calculated using the following formula: Total distance travelled/millage of the vehicle*cost of petrol per litre*no of days camp held. Operational effectiveness (the ratio between the input to run a dental care program and the output gained from the program) of the mobile dental vehicle and the portable dental chair was calculated using the formula below:

Total cost (direct+indirect) of service provision
Total numbers of patients who used the services in the same period

Statistical Analysis

The data were analysed employing the statistical package SPSS version 19.0. Descriptive statistics: Means, Standard deviation, and Frequency table, unpaired student t-test ($P<0.1$), ANOVA ($P<0.1$), and Tukey's post hoc test ($P<0.1$). The level of significance (P value) for all the statistical tests was set at <0.1 as the data was unequally distributed.

3. Results

The total cost of the mobile dental vehicle was calculated using direct and indirect cost in Indian rupees (INR); the total direct and indirect cost reached 38,71,050 INR. The total cost of the portable dental chair was calculated using direct and indirect cost, which was about 33,000 INR (Table 1). In MDV, for the academic years of 2017-18, 2018-19, and 2019-20, the total number of patients screened were 20,820 with the cost of screening for each patient being around 185.9/- INR. In portable dental chair, the total number of patients provided with treatment were 859 over three years with the cost of treating each patient around 38.4/- INR (Table 2).

Table 1: Capital cost for the purchase of mobile dental vehicle and portable dental chair

	MDV	
Direct Cost (in INR)	Vehicle Cost	34,00,000/-
	Dental set up installation	4,25,000/-
	Insurance	24,000/-
Indirect Cost (in INR)	Materials/ used (from 5 camps)	2000*5=10,000/-
	Power source (from 5 camps)	500*5=2,500/-
	Fuel (from 5 camps)	7,050/-
	Operating personnel (from 5 camps)	500*5=2,500/-
Total Cost (in INR)	(Direct+Indirect)	38,71,050/-
Portable dental chair		
Direct Cost (in INR)	Purchasing the chair	28,000/-
Indirect Cost (in INR)	Transportation, Labour cost, operating personnel and fuel)	5000/-
Total Cost (in INR)	Direct+Indirect	33,000/-

MDV: Mobile Dental Vehicle; INR: Indian rupees

Table 2: Distribution of the patients and the cost-effectiveness of Mobile dental vehicle and portable dental chair over three academic years

Academic years chosen	Screening		Patients benefitted		Teeth benefitted	
	Number of patients screened	Cost of screening	Number of patients benefitted	Cost of treating each patient	Number of teeth benefitted	Cost of treating each teeth
MDV						
2017–18	6930	558.6/-	5660	683.9/-	25641	151.0/-
2018–19	6963	555.9/-	4991	775.6/-	24935	155.2/-
2019 - 20	6927	558.8/-	4155	931.7/-	24842	155.8/-
Over all 3 years	20820	185.9/-	14806	259.0/-	75421	51.3/-
Portable dental chair						
2017–18	411	80.3/-	299	110.4/-	934	35.3/-
2018–19	415	79.5/-	296	111.5/-	921	35.8/-
2019 - 20	421	78.4/-	264	125.0/-	831	39.7/-
Over all 3 years	1247	26.5/-	859	38.4/-	2686	12.3/-

MDV: Mobile Dental Vehicle; INR: Indian rupees

In the academic year of 2017-18, 2018-19, and 2019-20, the total number of patients who benefitted from various treatments were 5660, 4991, and 4155, respectively. The mean comparison of the number of patients over the three academic years showed a significant reduction in the number of patients who needed treatment. With further analysis, a statistically significant difference was found between the academic years 2017-18 versus 2019-20 (Table 3). Within-group cost-effectiveness did not vary significantly over the three academic years in both MDV and portable dental chair; however, there was a statistically significant difference between MDV and portable dental chair for the cost of screening, cost of treatment of each patient, and cost of treatment of each tooth (Tables 4 and 5).

4. Discussion

Herein, we started a project under the title of "healing touch–a mobile health-care project of specialists" along with the Catholic Church Caritas–Goa, India. The mobile clinic was successfully used to provide quality medical and dental care (14-16).

Around 20,820 patients were screened in the present study utilizing MDV with the majority of treatments oriented towards preventive treatments. These results were in contrast to the study conducted by Rudolph M J who reported that around 6,184 patients were screened with only 46% of the treatment oriented toward prevention. In a national survey regarding dental school mobile units, nine were operational, three were planned, and two were discontinued (9, 10).

The majority of the patients in our study (13,700) were benefitted from topical fluoride treatment, which was closely followed by 13,352 patients benefitted with scaling, and around 11,672 with Glass Ionomer Cement (GIC) restoration in the MDV. These findings were similar to those of the study conducted by Mishra P and

Table 3: Mean comparison of the total number of the patients who benefitted from MDV over the three academic years

Treatment provided	2017-18 N	2018-19 N	2019-20 N
Total number of patients treated	5660	4991	4155
Scaling	5012	4215	4012
Topical fluoride	5487	3998	4127
Amalgam restoration	2758	2047	1854
GIC restoration	4251	3699	3767
Temporary restoration	3578	2578	1985
Extraction	4200	3654	2014
Mean±SD	4420.8±1046.7	3597.4±995.2	3130.5±1111.5
f value[a] (P value)* 2.69 (0.094)*			
post hoc[b] (P value) 2017-18 versus 2018-19 academic year–2.07 (0.330) 2017-18 versus 2019-2020 academic year–3.24 (0.082)* 2018-2019 versus 2019-2020 academic year–1.17 (0.689)			

[a]F value ANOVA, [b]Tukey's post hoc test, *P value significant <0.1

Table 4: Mean comparison of the cost-effectiveness of mobile dental vehicle and portable dental chair over the three academic years

	Academic years chosen	Mean±SD	f value[a] (P value)*
Mobile dental vehicle	2017–18	468.6±283.6	0.020 (0.9795)
	2018–19	504.7±326.9	
	2019–20	520.6±347.3	
Portable dental chair	2017–18	75.33±37.7	0.019 (0.9804)
	2018–19	75.6±38.0	
	2019–20	81.0±42.7	

[a] F value ANOVA, *P value significant <0.1

Table 5: Mean comparison of cost effectiveness of mobile dental vehicle and portable dental chair between the groups

	Year	MDV Cost (INR)	Portable dental chair Cost (INR)	t value[c]	P value*
Cost of screening each patient	2017–18	558.6	80.3	440.7	0.0001
	2018–19	555.9	79.5		
	2019–20	558.8	78.4		
Mean±SD		557.7±1.62	79.4±0.95		
Cost of treating each patient	2017–18	696.4	110.4	14.7	0.0001
	2018–19	803.0	111.5		
	2019–20	847.4	125.0		
Mean±SD		782.2±77.6	115.6±8.1		
Cost of treating each tooth	2017–18	151.0	35.3	57.0	0.0001
	2018–19	155.2	35.8		
	2019–20	155.8	39.7		
Mean±SD		154.0±2.6	36.9±2.4		

[c]Unpaired students t-test, *P value significant <0.1, MDV: Mobile Dental Vehicle; INR: Indian rupees

colleagues; they reported that scaling was one of the most frequently performed dental treatment followed by restoration and extraction in the dental camps (16).

Regarding the cost efficiency of the mobile dental van, 259.0/- INR (3.55 USD) was spent on treating each patient, which was found to be effective on treating the adopted school children. Concerning different dental treatments, the average amount spent per tooth was 154.0+2.6 INR (2.45 USD). These results were similar to those of the study conducted by Vashishtha and colleagues who reported that the efficacy of Mobile dental vans in the treatment of oral health problems was high. This is also on the contrary to the study

conducted by Molete and co-workers who indicated that the cost of screening and treatment per patient was 331 R (31 USD; 1,632.6 INR) and 743 R (69 USD; 3663.94 INR), respectively (9, 17-19).

Amalgam restoration was the least performed procedure in the present study due to various reasons, including aesthetic concerns, time consumption for triturating silver, and the possibility of mercury poisoning with young children around. Cavity preparation for amalgam requires the formation of dovetail, in which converging cavity walls is very important, performing these in a camp setting becomes difficult. Considering these factors amalgam restorations were performed less in the dental camps of present study.

The dental council of India, in its revised Masters in Dental Surgery (MDS) in Public Health Dentistry, has mandated each dental institution to procure MDV to provide services to the underserved population. Thus, the help of the Government sector could markedly improve the health status of our community.

In the present study, per patient cost treated with the portable dental chair was around 35/- INR. These results were in line with another successful dental care program using portable dental equipment for children residing in remote areas by El Salvador. Gambhir and co-workers (15) also reported similar results in their study where the cost of treating each patient was 35/- INR. In a study conducted in Thailand, the cost per patient was 35.49 USD (2,593.7 INR) and the cost per patient visit was 14.74 USD (1077.27 INR) at the mobile clinics, compared to 46.56 USD (3,403.2 INR) and 23.59 USD (1,724.3 INR) in the permanent clinics (15, 16).

Portable dental chair, when compared to MDV, has low start-up cost, low ongoing maintenance costs, and more basic equipment needed. However, additional space was needed to set up the chair in the camp site whereas in MDV, operatory is already present in the vehicle. Logistics was a problem for the portable chair as it needed separate vehicles to be transported from one place to another; this issue does not exist in MDV. Further time was needed to set up the chair while less time or no time is needed to set up MDV.

With the limited literature currently available concerning the efficacy and role of mobile dental units independently, MDV seems to be promising regarding restoration of the gap between health care provision and utilization. Meanwhile, there were a few weak points; primarily, generalizability of the study is limited because of sample selection from point of source and the limited time frame used in the study. Secondly, this study considered only six adopted schools of the institutions that use MDV and portable dental chair whereas the department of public health dentistry is conducted on an average of five or six camps, including other school camps and community camps per month. Lastly, due to its retrospective nature, the study was undertaken from a provider perspective and did not take into account patient and societal costs, which would have probably demonstrated cost savings on travelling to and from the fixed clinics, parents missing work, and school absenteeism by learners leading to loss of productivity. Future research should be conducted in order to evaluate different programs offered by the mobile dental unit.

5. Conclusion

The current paper investigated the costs of providing primary oral health care among adopted schools. MDV and portable dental chair were found to be cost-effective in delivering primary oral health care; however, the cost-effectiveness of portable dental chair was significantly effective compared to that of MDV.

The number of patients needing treatment significantly decreased from 2017-18 to 2019-20. Accordingly, it could be concluded that patients were benefitted from the MDV.

With self-sufficiency and cost-effectiveness, the use of MDVs could be a promising strategy to deliver oral healthcare to school children.

Conflicts of interest: None to declare.

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