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Mobile Clinic In Massachusetts Associated With Cost Savings From Lowering Blood Pressure And Emergency Department Use

Zirui Song[1], **Caterina Hill**[2], **Jennifer Bennet**[3], **Anthony Vavasis**[4], and **Nancy E. Oriol**[5]

Zirui Song: zirui_song@hms.harvard.edu

[1]Zirui Song is a medical degree candidate at Harvard Medical School, in Boston, Massachusetts

[2]Caterina Hill is a research associate in the Department of Global Health and Social Medicine at Harvard Medical School

[3]Jennifer Bennet is executive director of the Family Van, in Roxbury, Massachusetts

[4]Anthony Vavasis is director of medicine at the Callen-Lorde Community Health Center, in New York City

[5]Nancy E. Oriol is dean for students and an associate professor in anesthesia at Harvard Medical School

Abstract

Mobile health clinics are in increasingly wide use, but evidence of their clinical impact or cost-effectiveness is limited. Using a unique data set of 5,900 patients who made a total of 10,509 visits in 2010–12 to the Family Van, an urban mobile health clinic in Massachusetts, we examined the effect of screenings and counseling provided by the clinic on blood pressure. Patients who presented with high blood pressure during their initial visit experienced average reductions of 10.7 mmHg and 6.2 mmHg in systolic and diastolic blood pressure, respectively, during their follow-up visits. These changes were associated with 32.2 percent and 44.6 percent reductions in the relative risk of myocardial infarction and stroke, respectively, which we converted into savings using estimates of the incidence and costs of these conditions over thirty months. The savings from this reduction in blood pressure and patient-reported avoided emergency department visits produced a positive lower bound for the clinic's return on investment of 1.3. All other services of the clinic—those aimed at diabetes, obesity, and maternal health, for example—were excluded from this lower-bound estimate. Policy makers should consider mobile clinics as a delivery model for underserved communities with poor health status and high use of emergency departments.

Introduction

An estimated 2,000 mobile clinics nationwide collectively receive 6.5 million patient visits per year. The 548 mobile clinics listed on the Mobile Health Map[1] at the time of writing each receive on average 3,300 visits annually. These custom vehicles deliver a variety of services, including primary, preventive, and specialty care. They are staffed by community health workers and health educators, and sometimes by physicians and nurses. Mobile

Correspondence to: Zirui Song, zirui_song@hms.harvard.edu.

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clinics provide an important safety net for disease prevention and management in urban communities with poor health status and high emergency department usage.[2]

Despite the growth in the number of mobile clinics, their clinical impact and cost-effectiveness are largely unknown. In 2011 the Department of Health and Human Services Office of Minority Health announced funding for a research partnership with a nationwide collaboration of mobile clinics to evaluate their impact.[3]

Conceptually, mobile health clinics represent a paradigm shift in health care delivery by bringing care to underserved communities rather than waiting for patients to seek care. They aim to eliminate financial and logistical barriers as well as barriers related to community members' lack of trust in health care providers.[2, 4, 5]

The mission of these clinics is aligned with federal efforts to improve access to care and reduce disparities through the Affordable Care Act[6] as well as the Healthy People 2020[7] priorities—for example, through community-based education and prevention, chronic disease management, and promotion of public health infrastructure.

A fundamental challenge to evaluating mobile clinics is the absence of patient outcome data, because clinics often lack the resources to collect them. In this study we used a unique longitudinal data set to examine the clinical impact and cost-effectiveness of the Family Van, a large urban mobile clinic based in Boston, Massachusetts.

To estimate clinical impact, we assessed changes in blood pressure associated with visiting the clinic. Our major challenge was to identify a "treatment" effect in the absence of a control group. This challenge is common for public health interventions with voluntary take-up.

We used a longitudinal model with fixed effects to improve on cross-sectional analysis. We then estimated savings from these health gains and from patient-reported emergency department avoidance to establish a conservative lower bound for the clinic's return on investment. To our knowledge, this is the first such evaluation of a large urban mobile clinic using a longitudinal sample of patients.

Setting

The Family Van was established in 1992 by Beth Israel Hospital in Boston, and since 2001 it has been a program of Harvard Medical School. Its mission is to improve access to care, increase healthy behavior, and help people prevent and manage chronic diseases in Boston's underserved neighborhoods. It is funded by federal, state, and philanthropic supporters as well as by Harvard Medical School.[8]

The Family Van serves six neighborhoods with poor health and high emergency department use. The team provides health screening, monitoring, coaching, and referrals. It does not diagnose or treat. Rather, when needed, it refers patients to local neighborhood health centers and other partners for definitive diagnosis and treatment. It uses a "Knowledgeable

Neighbor" model[5] that aims to remove all barriers to services and create a social space for wellness in the community.

Staffed by health educators, a registered dietitian, and HIV counselors, the Family Van offers a drop-in service free of charge to patients. The team is multicultural and multilingual, and discussions are in the patient's primary language whenever possible. Patients lead the encounters: They decide how often to attend and what services to use. Some patients use the clinic for acute concerns, and some for monitoring chronic diseases. Others, particularly those without insurance, use it as the main point of access into the health care system.

Frequently addressed morbidities include hypertension, diabetes, obesity, hypercholesterolemia, glaucoma, HIV, and reproductive health issues. Three-quarters of all patients receive hypertension screening and education at their first visit. Blood pressure is measured using a sphygmomanometer and cuff. Repeated measures are taken to confirm elevated values.

Through health coaching, the team uses current American Heart Association[9] best practices to increase patients' health literacy and help them identify changes they are ready to make, particularly in the areas of nutrition, medication adherence, and exercise. The staff focuses on changes that patients find economically feasible, such as exercises they can do at home and healthy food that is both affordable and culturally appropriate.

Collaboration with neighborhood health centers and other partners is key, enabling the clinic to provide necessary referrals into the health care system. The clinic also provides support to address social determinants of health, such as unemployment, through coaching and referrals.

Study Data And Methods

Data Source

The mobile clinic database contained data from 80,000 anonymous patient visits from 1992 to 2009 (Appendix Exhibit 1).[10] After January 2010 deidentified unique patient codes were used, which made it possible to begin tracking patients across time and assessing the van's effect on patient outcomes.

For our analyses, we used the longitudinal sample of 5,900 patients who made a total of 10,509 visits from January 2010 through June 2012. The data set included patient demographic characteristics, insurance status, education, homeless status, source of usual care, blood pressure data, and avoided emergency department visits. The Harvard Medical School Office for Research Subject Protection approved the study protocol.

Analysis

For our descriptive analyses, we divided the longitudinal sample into two groups: "returners," who had at least one follow-up visit, and "nonreturners," who received care once but did not return. We compared baseline demographic, socioeconomic, and blood pressure variables between the two groups using *t* tests for continuous variables and the Pearson chi-square test for categorical variables.

Among the outcome measures tracked by the van, only systolic and diastolic blood pressure were clinically reliable and documented in the majority of visits. Because of unreliability or lack of power, three other potential outcome measures (blood glucose, total cholesterol, and body mass index) were deemed not suitable for the present analysis. For example, most patients were not fasting when they had their blood glucose monitored, which rendered their blood glucose level an unreliable measure of control.

For our statistical analysis of blood pressure, we would ideally compare changes in blood pressure among returners and nonreturners in a difference-in-differences analysis, if longitudinal data on nonreturners were available. Since this was not possible, we analyzed the returners using a longitudinal fixed-effects model at the patient level. In our baseline analysis, we included only patients who presented with high blood pressure at their initial visit (systolic blood pressure of ≥140 mmHg or diastolic blood pressure of ≥90 mmHg). These were the patients whom the clinic was more likely to target for blood pressure prevention and monitoring.

To assess the average change in blood pressure between patients' initial and follow-up visits, we used a linear regression model controlling for observable individual characteristics with fixed effects at the individual and location levels. The fixed effects absorb time-invariant traits and identify an association between changes in clinic visits and changes in blood pressure. Specifically, the model captured the average change in blood pressure between patients' initial and follow-up visits, which improved on cross-sectional analysis.

We controlled for age, sex, race or ethnicity, insurance status, education, homeless status, location of service, and patients' usual source of care. Standard errors were clustered at the patient level.

We conducted a number of sensitivity analyses to test our results. First, we replicated the model while omitting fixed effects, reverting from a longitudinal to a cross-sectional model. Second, we omitted all covariates other than age and sex. Third, we included a linear secular trend in the model. Fourth and last, we expanded our population to include patients with high or borderline high blood pressure (systolic blood pressure of 120–139 mmHg or diastolic blood pressure of 80–89 mmHg). We hypothesized that including this population would produce a treatment effect that was smaller but in the same direction.

All analyses were conducted using the statistical analysis software Stata, version 11. Results are reported with two-tailed *p* values.

Estimating Return On Investment

We calculated the mobile clinic costs using financial expenditure reports for the period January 2010–June 2012. We estimated health care savings generated by the clinic using the following two measures: blood pressure reduction and emergency department visits avoided.

To convert the mobile clinic–associated reductions in blood pressure into savings, we followed a three-step procedure. First, we converted blood pressure reductions into reductions in relative risk for myocardial infarction and stroke, using the well-accepted clinical relationship between blood pressure reduction and risk reduction for cardiovascular disease in the clinical literature.[11–18]

Second, we converted the relative risk reductions into cases of myocardial infarction and stroke avoided, using Massachusetts-specific data from people of similar ages in the Framingham Heart Study.[19] Third, we applied average thirty-month attributable costs of myocardial infarction and stroke per case to convert risk reduction into savings.[20] All dollars were adjusted to 2010 dollars. We describe the published algorithm and its associated data in Appendix Exhibit 2.[10]

To calculate savings from emergency department visits avoided, we used patient-reported data. At every visit, patients were asked: “Where would you have gone today if the mobile clinic had not been here?” We calculated the number of emergency department visits avoided as the total number of patients who answered “emergency department” at their earliest visit.

At subsequent visits, some patients reported again that they would have used an emergency department. Data from the Commonwealth of Massachusetts report on emergency department usage showed that some patients repeatedly use emergency departments for nonurgent issues.[21] However, to be conservative, we included the responses from only the earliest visit.

Using findings from the Massachusetts Division of Health Care Finance and Policy,[22] we applied an average cost of $474 to each emergency department visit avoided. This is the average cost of preventable or avoidable visits, which is lower than the average cost of all visits.

Our methods were designed to produce a conservative or lower-bound estimate of the return on investment. First, the mobile clinic provides a number of cost-effective prevention services in addition to blood pressure screening and counseling.[2, 23] However, we included only blood pressure benefits in the calculation of health benefits. Moreover, we included only benefits in returners who presented with high blood pressure during their initial visits. Thus, the return on investment excluded any benefits not related to blood pressure as well as any blood pressure benefits that accrued to returners without initial high blood pressure or to nonreturners. Additionally, the benefit of blood pressure reduction was derived only through lower risk of myocardial infarction and stroke, when in reality blood pressure reduction offers a broader array of health benefits.

Second, the population that the mobile clinic serves is probably more marginalized and less healthy than the Framingham Heart Study population. Therefore, using the Framingham Heart Study to estimate the incidence of myocardial infarction and stroke in the absence of the mobile clinic probably underestimates the true incidence. This analysis further renders our return on investment conservative.

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Third, to calculate cost savings from emergency department visits avoided, we used patients' reports of intention to use an emergency department only at their initial mobile clinic visit, although subsequent visits may also have been diverted from an emergency department. Moreover, we used a conservative estimate of the average emergency department visit cost.[22]

Limitations

Our data and methods are subject to several limitations. First, our longitudinal analysis lacked a comparison group. To the extent that our longitudinal (panel) data methods are an improvement over cross-sectional analysis, we were able to derive a less biased estimate of the association between mobile clinic visits and blood pressure. We acknowledge, however, that there were a number of potential confounding factors that we could not adjust for in the absence of an adequate control group. For example, people who visit the Family Van more than once may also be using other available health services more effectively and might have improved their health in the absence of the mobile clinic.

Second, we were concerned with self-selection bias, in that people who chose to return to the mobile clinic might be different from nonreturners in unobservable ways. This is a common concern for most evaluations of public health programs with voluntary take-up. To the extent possible, we documented the baseline differences between returning patients and nonreturners (Exhibit 1). In our statistical analyses, we controlled for observable covariates and tested the robustness of our findings.

Third, our blood pressure sample was small compared to the total population of patients ever served by the mobile clinic, which may limit the generalizability of our findings. However, baseline demographic characteristics of all mobile clinic patients over the past two decades have remained largely unchanged.

We were limited to blood pressure as the only suitable clinical outcome to study, and our conversion of blood pressure reduction into savings relied on the clinical literature. To the extent that our population was different from those in clinical studies from which measures of benefit were derived, our results might not be generalizable.

Our measure of avoided emergency department visits was based on patients' responses; therefore, we were concerned about reporting bias. Moreover, Massachusetts has a high rate of emergency department use, which might not be generalizable to other communities.[24] Finally, our return on investment was a lower bound, and the true return may be substantially larger.

Study Results

Patient Population And Emergency Department Avoidance

The majority of mobile clinic patients were black or Hispanic people with educational attainment at or below twelfth grade (Exhibit 1). Thirty-nine percent did not speak English as their primary language, with the top non-English languages being Spanish and Haitian Creole. Approximately 10 percent of patients were uninsured, and a similar proportion had not had a physical examination for two or more years. At their earliest visit, 2,851 patients reported that they would have gone to an emergency department if the mobile clinic had not been available, which suggests that 27 percent of all visits resulted in an avoided emergency department visit.

On average, returners were older and more likely to be female, compared to nonreturners. Returners were also more likely to be black, to have an education attainment of twelfth grade or below, and to report using a hospital or emergency department as their usual source of care.

During their initial visits, returning patients presented with an average systolic blood pressure of 124.0 mmHg and diastolic blood pressure of 77.3 mmHg. Initial systolic blood pressure was higher among returners than nonreturners, but the difference in initial diastolic blood pressures was not significant (Exhibit 1).

Effect On Blood Pressure

Among the 1,134 returning patients in our sample, 237 presented with high blood pressure during their initial visit. We analyzed changes in blood pressure for these patients only.

The patients' baseline characteristics were similar to those of returners without high blood pressure at their initial visit (Appendix Exhibit 3).[10] Their average systolic blood pressure was 143.2 mmHg, and their average diastolic blood pressure was 88.1 mmHg at the initial visit (Exhibit 2). Sixty-five percent had already been diagnosed with hypertension, 14 percent with diabetes, and 3 percent with hypercholesterolemia.

The patients made a mean of six visits to the clinic during the thirty-month period under evaluation. Ninety-six percent received health literacy education and coaching about cardiovascular health, 89 percent received nutritional counseling, and 49 percent discussed obesity prevention with clinic staff. All received screenings and support for other pertinent issues, such as mental health and health insurance.

Across all of their follow-up visits, the patients averaged systolic and diastolic blood pressures of 129.3 mmHg and 78.3 mmHg, respectively (Exhibit 2). In our statistical model, adjusted for patient demographic characteristics and other covariates, patients during repeat visits had average reductions of 10.7 mmHg (95% confidence interval: −13.0, −8.4) in systolic blood pressure and 6.2 mmHg (95% confidence interval: −7.4, −4.7) in diastolic blood pressure compared to the first visit (for full regression results, see in Appendix Exhibit 4).[10]

Sensitivity analyses were consistent with our main results (see Appendix Exhibit 5).[10] The significant negative association between mobile clinic visits and blood pressure remained robust when we expanded our analytic sample.

Return On Investment

The average reductions in systolic and diastolic blood pressure were associated with a 31.0 percent and a 33.3 percent reduction, respectively, in the relative risk of myocardial infarction.[11, 13] Similarly, the blood pressure reductions were associated with a 40.4 percent and a 48.8 percent reduction, respectively, in the relative risk of stroke. Following the literature, we averaged the systolic and diastolic effects to arrive at an overall relative risk reduction of 32.2 percent in myocardial infarction and 44.6 percent in stroke associated with the blood pressure reductions (Exhibit 3).

In a population ages 55–64 that is evenly divided among men and women, the incidence of myocardial infarction is estimated to be about 11.4 per 1,000 person-years, and the incidence of stroke about 3.3 per 1,000 person-years.[19] Using average attributable costs per case,[20] the reductions in incidence were estimated to have saved $235,254 from blood pressure reductions over the thirty-six-month study period (Exhibit 3).

With each avoidable emergency department visit costing on average $474 in Massachusetts,[22] we estimated total savings of about $1.4 million from the 2,851 reported emergency department visits avoided. These savings were much larger than the savings from blood pressure reduction. Thus, estimated savings from the use of mobile clinics were driven by the number of emergency department visits avoided.

Total mobile clinic savings were about $1.6 million from January 2010 through June 2012. Total operating expenditures during the same period were $1,222,886. Operating expenses included personnel salaries and benefits, vehicle operations and utilities costs, and mobile clinic administrative costs. The ratio of total savings to total expenditures, or return on investment, was thus 1.3 (Exhibit 3). This lower bound increased when any of the restrictions discussed above was relaxed. For example, when all visits, including initial and return visits, were eligible to be counted as emergency department visits avoided based on patient responses at each visit, the return on investment was 2.1.

Discussion

In the current fiscal environment, slowing the growth of health care spending is a national priority. The provisions of the Affordable Care Act include incentives for prevention and disease management. To date, limited attention has been given to mobile health clinics as a model to help achieve these goals.

Our pilot evaluation suggests that this model can be effective in supporting reductions in blood pressure in underserved communities. It also suggests that mobile clinics can be cost-effective as a delivery model for primary and secondary preventive care, based on savings from health improvement and emergency department avoidance.

The mobile clinic in our study operates in Massachusetts, which has near-universal insurance coverage and is an example of what other states may achieve with national health care reform. It is notable that the clinic did not see a decline in visitors after the Massachusetts health care reform in 2006 (Appendix Exhibit 5)[10] and that most people choosing to attend the mobile clinic had health insurance. These facts suggest that national demand for mobile clinics may not decline as insurance coverage increases with the provisions in the Affordable Care Act.

This analysis is consistent with evidence from Massachusetts that there continue to be barriers to primary care services after expanding coverage, including waiting times, copayments, complexities of navigating the system, and feelings of intimidation.[25–27] These are barriers that mobile clinics are designed to overcome.[4, 5, 28–30]

Emergency departments in Massachusetts have also continued to experience high utilization rates for nonurgent issues after reform, with the highest rates among publicly insured rather than uninsured patients.[21, 24] By providing care that is less expensive than emergency department visits, mobile clinics can potentially help to reduce health care costs.

This study joins a growing body of evidence that mobile clinics can improve access to health services.[2, 5, 28–30] To our knowledge, this is the first study to evaluate the clinics' impact on health outcomes. Hypertension is theoretically very manageable, but nationally only one in two people diagnosed with the condition has it under control. This is not simply because of a lack of insurance, as 80 percent of those with uncontrolled blood pressure are insured.[31] The challenge with hypertension management is sustaining adherence to medication and lifestyle changes.

The results of this study suggest that mobile health clinics may help patients address these challenges. Although it is possible that mobile health interventions work better for hypertension, other chronic diseases such as diabetes and hypercholesterolemia also require adherence to medication and lifestyle changes. Therefore, to the extent that mobile health clinics support adherence and educate patients on chronic disease management, the clinics' effects on blood pressure may be representative of benefits in other domains. Future research should examine the clinical impact of mobile health beyond blood pressure reduction.

The full economic impact of mobile clinics is difficult to estimate given the lack of reliable longitudinal data and data on observed emergency department avoidance. This article builds on prior work by Nancy Oriol and coauthors[2] but arrives at a much more conservative return on investment. The difference is mainly because Oriol and colleagues estimated the clinical benefit from the quality-adjusted life-years saved over the patients' lifetime and based the analysis on a range of services, not merely those related to hypertension. This calculus translates into a substantially larger financial benefit than that in the present analysis.

Given our conservative approach, the true return on investment most likely exceeds 1.3. However, more data are needed before a larger return can be substantiated.

We believe the main contribution of this pilot analysis is to demonstrate a positive lower bound for the return on investment. This return deserves emphasis because cost-saving interventions in health care are rare.[32] Many cost-effective interventions are not, on net, cost-saving, meaning that they cost more than they save. The potential for mobile clinics to be cost-saving may encourage researchers to study their impact more thoroughly.

Mobile health clinics serve a unique role for the underserved populations in our society. They deliver care to the full spectrum of at-risk populations, including medically complex patients, who may not effectively navigate the health care system and may rely on emergency departments for care; the homeless and uninsured; and people living in rural environments, who may lack access to any care. The clinics are often the providers of last resort in places where the mainstream health care system has not provided a point of access.

As policy makers look for effective ways to control health care spending while increasing access to care, they should consider mobile health clinics as a potentially cost-effective and clinically beneficial model of health care delivery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Exhibit 1

Demographic Characteristics of the Study Population.

Characteristic	Returners (N = 1,134)	Non-returners (N = 4,689)	p value
Age (yr)	56.8 ± 15.7	49.0 ± 19.5	<0.001
Male (%)	49.0	57.0	<0.001
Race (%)			
Black	68.3	60.8	<0.001
White	10.6	12.6	
Hispanic	13.9	18.9	
Other	7.2	7.7	
Insurance (%)			
Private	27.2	23.6	0.009
Medicare	13.3	11.3	
Medicaid/Dual eligible	49.2	54.2	
None (uninsured)	10.3	10.8	
Education (%)			
< 12th grade	16.2	21.4	<0.001
12^{th} grade	63.9	56.4	
> 12th grade	20.0	22.2	
Homeless (%)	4.0	5.0	0.07
Usual source of care (%)			
Community health center	33.0	40.3	<0.001
Hospital / ED	48.7	39.4	
Private physician	10.0	12.2	
Other	8.3	8.1	
Blood pressure at first visit			
Systolic (mmHg)	124.0	122.3	0.008
Diastolic (mmHg)	77.3	77.0	0.64

Source: Authors' analysis of 2010–2012 data from the Family Van database.

Notes: Plus–minus values indicate means ± standard deviation. Values for returners reflect data on initial visit. Private insurance includes plans in the Commonwealth Connector, the Massachusetts health insurance exchange which provides subsidized coverage for low-income individuals.

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Exhibit 2

Average change in blood pressure among returning patients with high blood pressure at initial visit (N=237).

	Initial visit	Follow-up visits	Unadjusted difference	Adjusted difference	p value
Blood pressure)					
Systolic (mmHg)	143.2	129.3	−13.9	−10.7	<0.001
Diastolic (mmHg)	88.1	78.3	−9.8	−6.2	<0.001

Source: Authors' analysis of 2010–2012 data from the Family Van database.

Notes: The adjusted difference and p value are retrieved from a longitudinal regression model with patient-level fixed effects. The full regression model with coefficients for all covariates are supplied in Appendix Exhibit 3.

Exhibit 3

Return-on-investment calculation.

Savings	
Blood pressure reduction (among 237 patients)	
Coronary heart disease (CHD)	
Baseline incidence per 1000 person-years	11.4
Relative risk reduction of CHD	32.2%
Cases avoided per 1000 person-years	3.67
Cases avoided per 593 Person-years (our sample)	2.17
Total CHD cost per case	$85,181
Total CHD cost avoided	$185,020
Stroke	
Baseline incidence per 1000 person-years	3.3
Relative risk reduction	44.6%
Cases avoided per 1000 person-years	1.47
Cases avoided per 593 person-years (our sample)	0.87
Total stroke cost per case	$57,618
Total stroke cost avoided	$50,234
Subtotal: savings from blood pressure reduction	$235,254
Emergency Department (ED) visits avoided	
Number of patients who reported that they would have visited ED if they had not visited mobile clinic	2,851
Cost per avoidable ED visit	$474
Subtotal: ED costs avoided	$1,351,546
Total savings	$1,586,800
Expenditures	
Total mobile clinic expenditures (January 2010–June 2012)	$1,222,886
Return-on-investment (Savings / Expenditures)	**1.3**

Source: Authors’ analysis using data reported by the National Heart, Lung, and Blood Institute, Massachusetts Department of Health Care Financing and Policy, published event-based cost estimates, and the mobile health clinic’s cost data.

Note: Methods for the step-by-step calculation of return-on-investment are described in Appendix Exhibit 2.