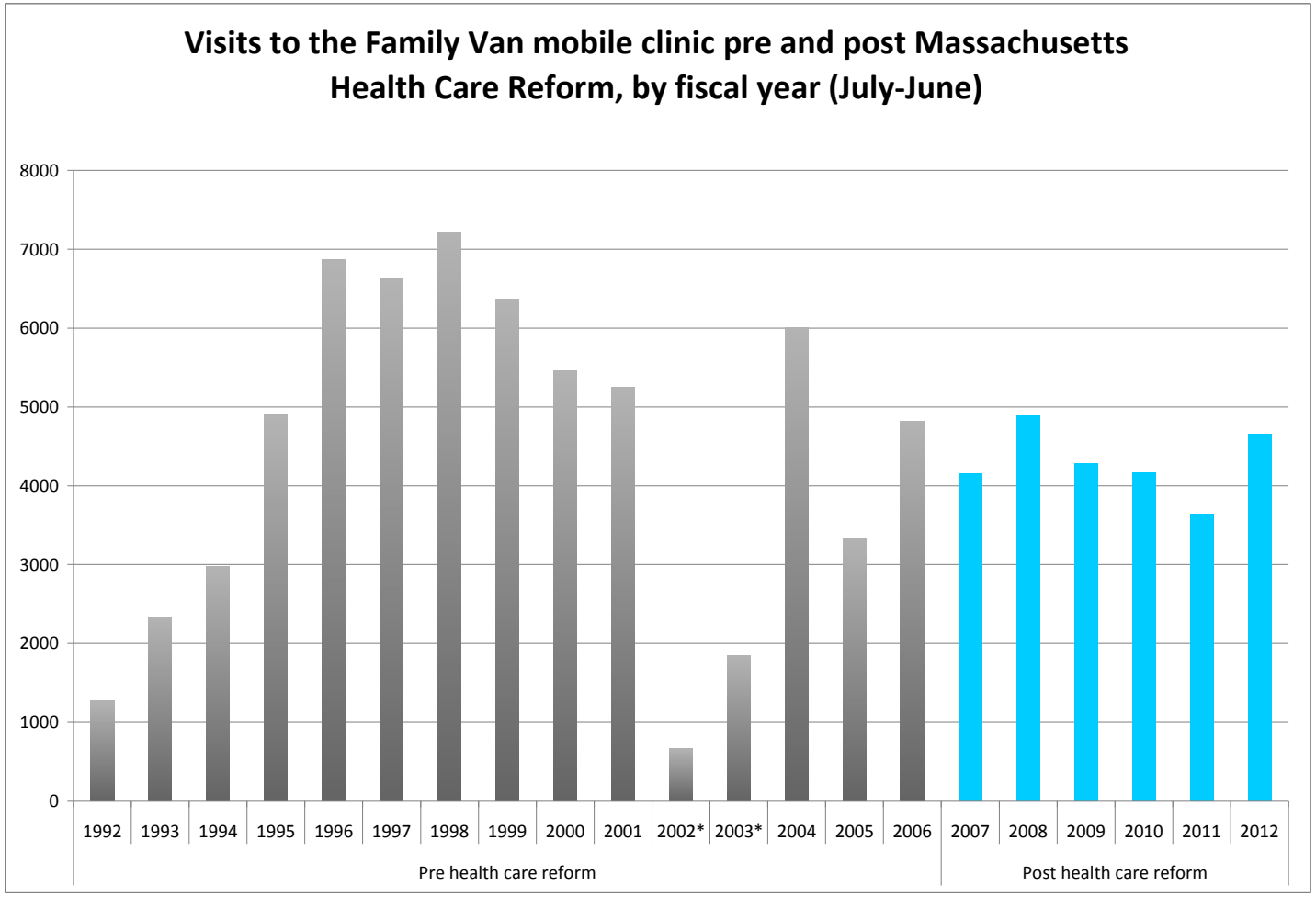
Song Z, Hill C, Bennet J, Vavasis A, Oriol NE. Mobile clinic in Massachusetts associated with cost savings from lowering blood pressure and emergency department use. Health Aff (Millwood). 2013;32(1).

Appendix: Supplemental Materials

Song Z, Hill C, Bennet J, Vavasis A, Oriol NE. Mobile clinic in Massachusetts associated with cost savings from lowering blood pressure and emergency department use. Health Aff (Millwood). 2013;32(1).

Appendix Exhibit 1: Visits to the Family Van mobile clinic.



Source: Authors' analysis of 1992-2012 data from the Family Van database.
Note: Each year denotes the fiscal year, which ranges from the previous June to the current July. The clinic was only partially in operation during fiscal year 2002.

Song Z, Hill C, Bennet J, Vavasis A, Oriol NE. Mobile clinic in Massachusetts associated with cost savings from lowering blood pressure and emergency department use. Health Aff (Millwood). 2013;32(1).

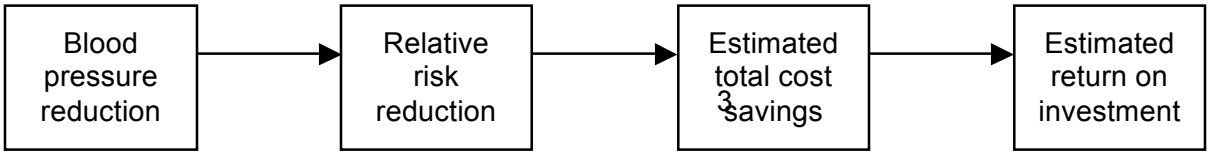
Appendix Exhibit 2: Methods for calculating return-on-investment.

Overview

We surveyed the clinical literature and reviewed a number of large randomized controlled trials and meta-analyses that examined the relationship between blood pressure changes and risk of cardiovascular disease events.[11-18] Three general findings from the literature are important to note. First, there is a statistically robust relationship between blood pressure reduction and lower risk of heart attack and stroke. Second, the magnitude of risk reduction is constant for a given blood pressure reduction starting from any initial blood pressure level (down to 110 mmHg systolic and 70 mmHg diastolic).[13] Third, the benefits of lower blood pressure differ by age.

Using a published algorithm developed by a comprehensive meta-analysis of 71 clinical trials and 61 cohort studies, we converted the reduction in blood pressure associated with mobile clinic visits to reductions in the relative risk of coronary heart disease events (defined as fatal or non-fatal myocardial infarction or sudden cardiac death) and in the relative risk of stroke (defined as hemorrhagic or ischemic stroke).[11,13] Given that benefits differ by age, we used the algorithm specific to individuals 50-59 years old, within which the average age of our returner population falls.

We used statistics from the National Heart, Lung, and Blood Institute and cost estimates of cardiovascular diseases to quantify the total savings from the relative risk reduction in cardiovascular disease events calculated above.[19,20] Details of these calculations are described below. In our final step, we calculated the ratio between these savings associated with the mobile clinic and the total costs of operating the mobile clinic to arrive at a lower-bound of the return-on-investment.



Step 1: Methods for calculating relative risk reduction in disease events from a reduction in blood pressure associated with mobile clinic visits.

Our major clinical source of conversion information came from the 2009 meta-analysis by Law, Morris, and Wald, which reviewed over 150 blood pressure trials, and the largest published meta-analysis of cohort (prospective observational) studies by the Prospective Studies Collaboration in 2002.[11,13] We used the algorithm developed by Law, Morris, and Wald (2009) that calculates expected reduction in disease events for a specified reduction in blood pressure using age group-specific regression coefficients found in Appendix Table 3 of their paper.

The formula is as follows. For each age group-specific regression slope, S, the relative risk reduction is given by $S^{d/20}$ for systolic blood pressure and $S^{d/10}$ for diastolic blood pressure, where d represents the decrease in blood pressure (mmHg). For the 50-59 year old population, the table below shows the values for S (from the published regression coefficients), d (from our regression model), and the resulting relative risk reduction for coronary heart disease events and stroke from applying the formulas. We calculated an average relative risk reduction for coronary heart disease events and for stroke by taking the average of the systolic and diastolic relative risk reductions.

Coronary heart disease events

	Regression coefficient (S)	Blood pressure reduction (d)	Relative risk reduction
Systolic	0.50	10.7 mmHg	31.0%
Diastolic	0.52	6.2 mmHg	33.3%
			Average: 32.2%

Stroke

	Regression coefficient (S)	Blood pressure reduction (d)	Relative risk reduction
Systolic	0.38	10.7 mmHg	40.4%
Diastolic	0.34	6.2 mmHg	48.8%
			Average: 44.6%

Step 2. Methods for calculating cases of coronary heart disease and stroke averted from reductions in relative risk.

Next, we converted relative risk reductions into reductions in the incidence of coronary heart disease events and stroke. Using data from the National Heart, Lung, and Blood Institute,[19] which provides incidence rates of cardiovascular diseases for Massachusetts from the Framingham Heart Study, we adopted baseline incidences of 11.4 cases per 1000 person-years for coronary heart disease events (chart 2-7) and 3.3 cases per 1000 person-years for stroke (chart 2-28). We arrived at 11.4 and 3.3 by calculating an average of the male incidence and female incidence reported in both coronary heart disease events (chart 2-7) and stroke (chart 2-28), because the mobile clinic returning patients were about 50 percent male and 50 percent female.

Applying the relative risk reductions to these baseline incidence rates, we estimated 3.7 and 1.5 cases of coronary heart disease events and strokes avoided per 1000 person-years, respectively. Our sample of 237 returners who had high blood pressure at their initial visits accounted for 592.5 person-years over the 2.5-year study period. Therefore, 3.7 and 1.5 cases per 1000 person-years prorated to 592.5 person-years produce an estimated 2.2 coronary heart disease events and 0.9 strokes avoided in our sample.

Step 3. Methods for calculating savings from cases of coronary heart disease and strokes avoided and the final return-on-investment.

We converted reductions in incidence into cost savings by using estimates of 24-month attributable costs from event-based studies by O'Sullivan et al (2011).[20] We used 24-month attributable costs because our study period was close to 2 years, and prorated the costs to 30 months to match our study period. For coronary heart disease, we used the 24-month attributable costs for a non-fatal myocardial infarction, which was $68,145 (inflated to 2010 U.S. dollars from the $64,900 reported in 2007 U.S. dollars in O'Sullivan et al.), prorated to $85,181. For stroke, we used the average of the 24-month attributable costs for non-fatal ischemic stroke ($19,740 in 2010 U.S. dollars) and non-fatal hemorrhagic stroke ($72,450 in 2010 U.S. dollars), which produced an estimate of $46,095, prorated to $57,618.

Multiplying the 2.2 cases of coronary heart disease events avoided in our sample by $85,181 per case, we estimated coronary heart disease savings of $185,020.31. Similarly, multiplying the 0.9 strokes avoided in our sample by $57,618 per case, we estimated stroke savings of $50,233.94. Adding these two savings together, we derived a subtotal of savings from blood pressure reduction of $235,254.25 over the 2.5 years.

Final return-on-investment calculation

To this subtotal, we added the savings from avoidable emergency department visits, which is shown in Exhibit 4. In total, 2,851 of the 5,900 individuals reported at their earliest visit that they would have visited an Emergency Department if the mobile clinic were not there. Multiplying each ED visit

avoided by Massachusetts-specific costs of $474,[21] we derived savings of $1,351,546 from ED visits avoided. Thus, the total mobile clinic savings over the 2.5 years were $235,254 + $1,351,546= $1,586,800.

Total mobile clinic costs included all costs related to van service delivery: personnel salaries and benefits, occupancy costs, utilities, van operations, and administrative costs. We divided total savings ($1,586,800) by total mobile clinic costs ($1,222,886), to arrive at a return-on-investment of 1.3.

Appendix Exhibit 3: Baseline characteristics of returners with and without high blood pressure during their initial mobile clinic visit.

Characteristic	Returners with high blood pressure during initial visit (N = 237)	Returners without high blood pressure during initial visit (N = 897)	p value
Age (yr)	58.0 ± 12.5	56.4 ± 16.5	0.93
Male (%)	40.9	51.6	0.001
Race (%)			
Black	73.5	66.3	0.13
White	7.7	11.5	
Hispanic	13.2	14.2	
Other	5.5	7.7	
Insurance (%)			
Private	23.5	28.5	0.15
Medicare	12.5	13.6	
Medicaid/dual eligible	52.2	48.2	
None	11.8	9.8	
Education (%)			
< 12th grade	16.5	16.0	0.35
12^{th} grade	66.5	63.0	
> 12th grade	16.9	21.0	
Homeless (%)	5.5	3.5	0.14
Usual source of care (%)			
Community health ctr.	34.9	32.4	0.90
Hospital / Emer. Dept.	47.1	49.2	
Private physician	9.9	10.1	
Other	8.1	8.3	

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

Note: Results are from a longitudinal model with patient fixed effects. Coefficients on indicator variables for each location of service are not shown. Robust p-values in parentheses. Standard errors were clustered at the patient level.

Appendix Exhibit 4: Regression results of main blood pressure analysis.

	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)
Repeat indicator	-10.71	-6.218
	(<0.001)	(<0.001)
Age	-0.392	-0.175
	(0.229)	(0.349)
Male	2.343	-4.47
	(0.755)	(<0.001)
Insurance		
Uninsured	Reference	Reference
Medicaid	-3.447	-1.238
	(0.140)	(0.477)
Medicare	-6.083**	-0.546
	(0.0167)	(0.752)
Private	-1.442	-0.505
	(0.539)	(0.766)
Race		
Black	Reference	Reference
White	-2.516	1.816
	(0.332)	(0.400)
Hispanic	0.537	2.649
	(0.900)	(0.129)
Other	-0.920	1.976
	(0.747)	(0.195)
Education		
Less than 12th grade	Reference	Reference
12th grade	0.227	-0.303
	(0.872)	(0.737)
More than 12th grade	0.231	-0.528
	(0.872)	(0.573)
Homeless	4.121*	2.235
	(0.0872)	(0.183)
Usual source of care		
Community health center	Reference	Reference
Hospital / emergency dept.	1.321	1.312
	(0.263)	(0.124)
Private physician	2.853	0.167
	(0.185)	(0.896)
Other	5.530**	2.871**
	(0.0145)	(0.0269)

Constant	163.5*** (<0.001)	94.93*** (<0.001)
Observations	1,360	1,360
R-squared	0.121	0.090
Patients	237	237

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

Note: Results are from a longitudinal model with patient and location fixed effects. Robust p-values in parentheses. Standard errors were clustered at the patient level.

Appendix Exhibit 5: Sensitivity analyses

	(1) Omitting individual fixed effects		(2) Omitting covariates except age and sex		(3) Controlling for secular trend		(4) Including patients with borderline high blood pressure	
Blood pressure (mmHg)	Systolic	Diastolic	Systolic	Diastolic	Systolic	Diastolic	Systolic	Diastolic
Repeat visit indicator	-13.29	-7.141	-11.62	-5.999	-10.05	-6.126	-4.951	-2.989
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Age	0.00741	-0.454	-0.0155	-0.0752	-0.181	-0.146	-0.266	-0.165
	(0.947)	(0)	(0.963)	(0.667)	(0.540)	(0.428)	(0.232)	(0.239)
Male	-4.708	-1.265	3.417	-3.536	2.666	-4.425	4.666	-3.356
	(0.0427)	(0.386)	(0.625)	(<0.001)	(0.734)	(<0.001)	(0.485)	(<0.001)
Insurance								
Uninsured	Ref	Ref			Ref	Ref	Ref	Ref
Medicaid	2.093	0.388			-3.426	-1.235	-3.557	-0.907
	(0.482)	(0.812)			(0.141)	(0.478)	(0.00326)	(0.354)
Medicare	-0.585	-0.341			-5.946**	-0.527	-4.154	0.0541
	(0.850)	(0.852)			(0.0192)	(0.762)	(0.00274)	(0.957)
Private	3.276	1.326			-1.574	-0.523	-2.259	-0.639
	(0.273)	(0.437)			(0.502)	(0.757)	(0.0671)	(0.506)
Race								
Black	Ref	Ref			Ref	Ref	Ref	Ref
White	2.505	-0.0458			-1.908	1.900	-3.008	-0.216
	(0.443)	(0.983)			(0.434)	(0.395)	(0.105)	(0.892)
Hispanic	2.901	0.454			1.021	2.717	0.271	1.834
	(0.530)	(0.794)			(0.819)	(0.132)	(0.914)	(0.271)
Other	-2.355	-4.085*			-0.558	2.027	-1.119	0.904
	(0.289)	(0.0734)			(0.837)	(0.193)	(0.444)	(0.404)

Education								
Less than 12th grade	Ref	Ref			Ref	Ref	Ref	Ref
12th grade	1.098	0.661			0.233	-0.302	0.947	-0.433
	(0.491)	(0.516)			(0.869)	(0.739)	(0.279)	(0.447)
More than 12th grade	0.449	0.0996			0.309	-0.517	1.240	0.231
	(0.774)	(0.914)			(0.831)	(0.579)	(0.147)	(0.680)
Homeless indicator	5.746	4.533			4.204	2.247	2.338	0.466
	(0.0195)	(0.0271)			(0.0795)	(0.180)	(0.0797)	(0.642)
Usual source of care								
Community health center	Ref	Ref			Ref	Ref	Ref	Ref
Hospital / Emer. Dept.	3.969	2.514			1.259	1.303	0.860	1.018
	(0.00294)	(0.0126)			(0.292)	(0.127)	(0.247)	(0.0229)
Physician	1.796	0.470			2.685	0.144	2.046	0.364
	(0.444)	(0.774)			(0.217)	(0.911)	(0.0991)	(0.596)
Other	8.03	3.285			5.578	2.878	1.747	1.643**
	(0.0173)	(0.0791)			(0.0134)	(0.0275)	(0.162)	(0.0422)
Secular trend					-0.0920	-0.0128		
					(0.275)	(0.796)		
Constant	142.7	113.1	140.7	91.15	150.9	93.16	146.8	91.59
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Observations								
R-squared	1,360	1,360	1,561	1,561	1,360	1,360	3,132	3,132
Subjects	0.156	0.329	0.099	0.065	0.122	0.090	0.042	0.031

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

Note: Results are from a longitudinal model with patient fixed effects. Coefficients on indicator variables for each location of service are not shown. Robust p-values in parentheses. Standard errors were clustered at the patient level.