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Hypertension identification via emergency responders: A randomized controlled intervention study

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ABSTRACT

Objective. The objective was to test the effectiveness of a mail campaign that included blood pressure (BP) measurements from patients treated by emergency medical technicians (EMTs) to motivate them to (re) check their BP at a fire station. The mailing used a 2 × 2 research design tailoring on risk and source personalization.

Method. In this randomized controlled trial, participants were randomized into a control group or one of four experimental groups. Participants residing in one of four fire departments in a Pacific Northwest metropolitan area were eligible if they had a systolic BP ≥ 160 mm Hg and/or diastolic BP ≥ 100 mm Hg when seen by EMTs during the study period (July 2007–September 2009).

Results. Of 7106 eligible participants, 40.7% were reached for a follow-up interview. Multivariable logistic regression analysis showed that although the absolute number of fire station BP checks was low (4%), participants who received any mailed intervention had a 3 to 5-fold increase in the odds of reporting a fire station BP check over controls. Fire station visits did not differ by type of tailored mailing.

Conclusion. Partnering with Emergency Medical Services is an innovative way to identify high-risk community members for population health interventions.

Introduction

Heart disease is the number one killer of Americans, and stroke is the fourth leading cause of death in the U.S. (CDC, 2009). High blood pressure (BP) is a significant risk factor for heart disease and stroke (AHA, 2010) and affects about 76 million adult Americans (AHA, 2012; NHLBI, 2012). Randomized controlled trials have shown that lowering BP results in significant reductions in cardiovascular mortality and morbidity (Kriehard et al., 2009). Current hypertension management guidelines recommend target BP measures below 140/90 mmHg (AHA, 2010).

Measuring BP is often part of routine procedures for patient evaluation in medical care facilities. However, the lack of a regular source of care is associated with untreated hypertension (Spatz et al., 2010) and lack of insurance with fewer BP checks and inadequate BP control compared to privately insured individuals (Duru et al., 2007). Individuals who are poor and/or uninsured are more likely to use emergency care as a source of health care (Lucas and Sanford, 1998; Northington et al., 2005; Svenson, 2000).

In the prehospital care delivery system, emergency medical technicians (EMTs) and paramedics routinely collect medical information that might be indicative of chronic disease. Emergency Medical Services (EMS) take vital signs (including BP) on the majority of patients regardless of the reason for the call. These data have traditionally been archived without follow-up or feedback to the patients (Trevino et al., 2008). As EMS serves a broad cross-section of the population there might be an opportunity to identify community members at risk for uncontrolled high BP via emergency responders. Our study aims were (1) to report BP information back to patients identified by EMTs during lower-acuity 911 visits as potentially at risk for uncontrolled hypertension; and 2) to motivate them to have their BP checked again at a local fire station.

Methods

Setting

The study was conducted in a large metropolitan area in the Pacific Northwest between July 2007 and September 2009. We partnered with

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four large fire departments for this project (Fig. 1). Together these four departments serve approximately one-quarter of the total population of King County, Washington. In King County, Washington, the EMS system responds to approximately 7% of the population annually (Trevino et al., 2008). Eligible participants were identified from the medical incident report form (MIRF) database maintained by Public Health Seattle-King County for the medical emergency responses in King County, Washington. EMS responders fill out an MIRF for each patient. The MIRF includes information on patient demographics, the reasons for the 911 call, procedures and diagnosis by EMTs, vital signs, patient contact information, and outcome of the EMS encounter, including whether the patient was transported to hospital.

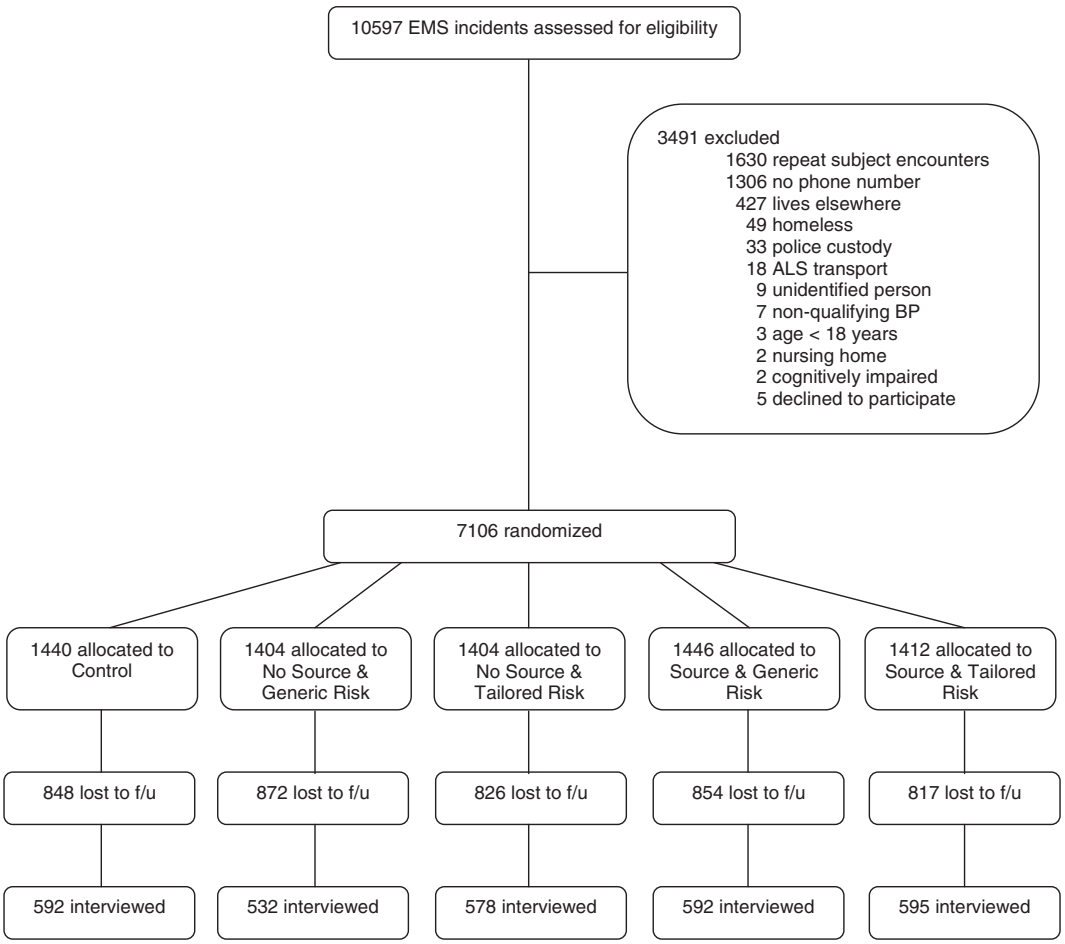
Eligibility criteria

Patients were eligible for our study if the data recorded on the MIRF noted a systolic BP ≥ 160 mm Hg and/or diastolic BP ≥ 100 mm Hg. Even given the "white coat phenomenon", where BPs increase due to situational factors (Baguet, 2012), these values were deemed high enough to be of concern. Participants had to be at least 18 years old, have an address in or near one of the areas served by the participating fire departments, and have a phone number recorded on the MIRF or publicly available on a web-based residential telephone directory. Patients transported by paramedics (rather than EMTs) to hospital were excluded from the study, as paramedic transport indicates a more serious medical problem. Patients transported by police or sheriff were excluded also, as were those attended by EMS at a jail or police station or other custodial setting. Residents of nursing homes were excluded due to their regular access to nursing care. Individual participants were enrolled only once, even if they were seen multiple times by EMS during the study interval.

Intervention

Formative research (Meischke et al., 2012) informed all aspects of the intervention and study protocols. Eligible participants from each fire department were randomized by study staff using SPSS syntax to generate random assignments into a control group or one of four experimental groups. Randomization was conducted within each of the 4 participating fire departments within blocks of 100 cases, stratified so that within every 100 cases, 1/5 were assigned to each of the 5 study arms: 20 subjects to each of the 4 intervention groups and 20 to the control group. The randomization assignment template was devised in advance of case enrollment; within each 100 cases, individuals were assigned to the next randomization condition in pre-determined sequence according to the chronological date and time of their EMS response. Study staff who sent the intervention mailings were aware of the randomization assignments, as those determined the mailing content, but the study interviewers were blinded.

The intervention comprised a direct mailing to the experimental groups, consisting of a letter and a high BP alert card. The content was based on the Health Belief Model (HBM) with varied personalized risk information and source personalization. HBM is a value-expectancy model that suggests that risk perceptions (i.e. perceived threat to health) motivate behavior change if the perceived benefits of the recommended action outweigh the barriers to the action (Rosenstock, 1990; Rosenstock et al., 1988). All mailings included a letter with information about the participant's risk of having uncontrolled hypertension, severity of having uncontrolled hypertension, benefits



[a]The study took place in four fire districts in a metropolitan area in the Pacific northwest from July 2007 through September 2009.

Fig. 1. The study took place in four fire districts in a metropolitan area in the Pacific northwest from July 2007 through September 2009.

of screening, and ease with which one can get a BP check at a local fire station free of charge (reducing barriers).

The communication intervention employed a 2 × 2 design, manipulating personal risk information (generic or tailored) and EMT personalization (image of local crew or generic insignia). As the literature suggests that health information tailored to individual characteristics can be more effective in behavior change than non-tailored health messages (Kreuter and Wray, 2003; Petty and Priester, 1994) we sent half the patients a mailing including their actual BP values taken at the scene by an EMT, whereas the other half received the mailing with the message that their BP was found to be "very high" but without the specific values. Based on formative research, we knew that community residents think highly of their local fire fighter crews, and we wanted to test the effectiveness of using the EMT as the message source. So in addition to the BP message variation, we randomized half the patients to a mailing featuring an EMT crew from the responding fire department, whereas the other half received the mailing without this visual image, showing instead the fire department insignia. See Meischke et al. (2012) for a detailed description of the intervention. All mailings listed the department fire stations and their addresses on the back of the intervention piece.

The study outcome was defined as self-report of a fire station BP check. We hypothesized that participants who received any mailing (intervention group) would be more likely to visit a local fire station for a BP check than participants who did not receive a mailing (control group). Furthermore, we hypothesized that participants who received the personalized risk information would be more likely to get a fire station BP check than those who received a mailing with just the "generic risk message". The source manipulation was more exploratory, and we did not have a priori hypotheses regarding its likely effect.

Evaluation

Intervention participants were called approximately one month after the mailing to find out if they went for a BP check at a local fire station. Controls, who did not receive a mailing, were called 6 to 8 weeks after their 911 visit in order to interview control and intervention groups at approximately the same length of time after the EMS visit. Half received a short survey and half received a much longer survey. Both surveys included demographic characteristics as well as the question of whether the participant had checked his/her BP within the past month, and if "yes", at what location or locations. The longer survey included questions about HBM variables as well as intervention evaluation questions (i.e. awareness, liking of the brochures). Study staff obtained verbal informed consent from participants before conducting the phone surveys. This study was approved by the Human Subjects Institutional Review Board of the University of Washington and the King County Research Administrative Review Committee.

Analysis

Descriptive statistics were used to describe the study population. Study population characteristics for categorical variables were compared between fire departments using the Chi-square statistic. For continuous variables, we used the t-test or one-way ANOVA when tests for homogeneity of variance were non-significant, or non-parametric Mann–Whitney U or Kruskall–Wallis statistics when the variances differed significantly between groups. Bivariate analyses were performed between the people who were interviewed and those who were not to assess systematic biases in our sample. Multivariable logistic regression was used to assess the effect of the four mailing interventions on the main outcome (self-report of fire station BP check) while accounting for demographic and department differences in our sample. A two-tailed p-value less than 0.05 was considered to be statistically significant. All analyses were conducted using PASW Statistics 18.0 (copyright 2009 SPSS Inc.).

Results

Of the 10,597 EMS responses for patients who were found to have high BP during the study period, 7106 were eligible for inclusion in the study. Across the fire departments subjects had the following demographic characteristics: 58.6% were female, average age 62.6 years (SD 19.4) with a range from 18 to 106 years, 71.1% were seen at a residence, and the mean qualifying BPs were 177.4 mm Hg systolic and 103.5 mm Hg diastolic. The primary reason for ineligibility was a repeat 911 visit and lack of a phone number on the MIRF and no phone number found in a public telephone directory. Ineligibility due to lack of a phone number varied between the fire departments, from a low of 11% to a high of 23%.

Participants who met study inclusion criteria except for missing phone numbers were more likely to be male (16.8% of men compared to 14.6% of women), less likely to be at a residential location (59.6%

Table 1
Study cohort characteristics by arms (n = 2889).[a]

	Control (n = 592)	No source & generic risk (n = 532)	No source & tailored risk (n = 578)	Source & generic risk (n = 592)	Source & tailored risk (n = 595)	Total (n = 2889) col% (n)	p-value[b]
Fire department, row% (n)							0.82
Agency 1	19.9 (91)	15.9 (73)	20.3 (93)	20.7 (95)	23.1 (106)	16.0 (458)	
Agency 2	21.3 (190)	18.8 (168)	19.8 (177)	19.9 (178)	20.2 (181)	30.7 (894)	
Agency 3	20.4 (127)	17.8 (111)	19.1 (119)	22.8 (142)	19.9 (124)	21.6 (623)	
Agency 4	20.1 (184)	19.7 (180)	20.7 (189)	19.4 (177)	20.1 (184)	31.7 (914)	
Age (years), mean ± SD	64.2 ± 18.6	63.4 ± 18.8	64.3 ± 18.5	64.2 ± 17.2	63.4 ± 18.0	63.9 ± 18.2	0.79
Gender, col% (n)							0.75
Female	60.1 (356)	62.4 (332)	63.3 (366)	60.1 (356)	61.3 (365)	61.4 (1775)	
Male	39.9 (236)	37.6 (200)	36.7 (212)	39.9 (236)	38.7 (230)	38.6 (1114)	
Location of 911 event, col% (n)							0.71
Home/residence	71.8 (425)	70.7 (376)	71.3 (412)	73.0 (432)	74.1 (440)	72.2 (2085)	
Other	28.2 (167)	29.3 (156)	28.7 (166)	27.0 (160)	25.9 (154)	27.8 (803)	
[missing]	[1]	[1]					
Initial systolic blood pressure (mm Hg), mean ± SD	174.8 ± 21.7	175.1 ± 19.1	175.4 ± 19.9	174.9 ± 19.2	174.8 ± 17.1	175.0 ± 19.5	0.87
Fire station BP check after 911 event, col% (n)							0.002[c]
Yes	1.4 (8)	6.6 (35)	4.2 (24)	5.4 (32)	4.9 (29)	4.4 (128)	
No	98.6 (584)	93.4 (497)	95.8 (554)	94.6 (560)	95.1 (566)	95.6 (2761)	
BP checked in the last month (any location), col% (n)[d]							0.55
Yes	83.4 (491)	85.6 (453)	86.9 (498)	84.8 (498)	85.3 (501)	85.2 (2441)	
No/don't know	16.6 (98)	14.4 (76)	13.1 (75)	15.2 (89)	14.7 (86)	14.8 (424)	

[a] The study took place in four fire districts in a metropolitan area in the Pacific northwest from July 2007 through September 2009.
[b] Based on chi-squared tests of homogeneity of proportions among all five arms.
[c] Test of homogeneity of proportions among all four intervention arms (p = 0.321); pairwise comparisons with Control: no source & generic risk (p < 0.001); no source & tailored risk (p = 0.003); source & generic risk (p = 0.001); source & tailored risk (p < 0.001).
[d] The N for this row is 2865, not 2889, based on who answered that question on the interview.

compared to 71.2%), less likely to have a repeat EMS visit during the study period (9.2% compared to 12.8%) and younger, both overall (median age 55 versus 64) and within gender (median age 51 versus 58 for men, 60 versus 68 for women).

Ninety-three percent of the 5495 intervention participants were presumed successfully reached by mail, that is, the mail was not returned to us. Forty-one percent of the 7106 eligible participants were successfully reached by phone one month post mailing of the brochures. The main reason for not interviewing the other eligible participants (59.3%) was the inability to reach them by telephone despite an apparent good telephone number and multiple (15 times) attempted calls (31%), which resulted in calls not answered, reaching an answering machine, or reaching a busy signal. Another 25% of non-interviewees refused to participate when contacted, and, for another 23%, no accurate telephone number could be found. These phone numbers included wrong numbers, business numbers, were disconnected, or no longer in service. Finally, 21% could not be reached for a variety of reasons such as: participant unavailable, language barrier, disabled and/or not able to participate, deceased, etc.

Table 1 shows that the randomization was successful as subject characteristics did not differ between the four intervention arms and the control arm. There was a significant difference in the outcome of interest, self-report of a fire station BP check. Of the 2,889 participants for whom we had a one-month survey, 128, or 4.4%, reported visiting a fire station for a BP check during the study period. Only 1.2% of participants in the control arm reported a visit to a local fire station for a BP check, compared to an average of about 5% across the four intervention arms (Chi-square = 20.77, 4 d.f., $p < 0.001$). As seen in the table, the majority of participants responding to the interview reported a BP check in the past month at any location. The percentages did not differ between study arms. In a sub-analysis (data not shown) we did not find any statistically significant difference for fire station BP check between the group of patients who were left-at-scene (no transport) and patients who were transported to hospital. Patients who were not transported did report checking their BP in the past month significantly less (82%) than those who were transported (86%) ($P < .05$).

Table 2 compares the eligible subjects who were interviewed with those who were not interviewed. Those not interviewed were more likely to be male, younger, and less likely to have a repeat EMS visit during which high BP was measured during the study period. The proportions interviewed differed by fire department, with a low of 35.6% to a high of 44%. There were no differences by interview status for randomization arm, location of 911 event, outcome following EMS assessment, BP values, or availability of addresses to which we could mail the study materials (for non-controls).

Table 3 shows that receiving any brochure led to a 3 to 5-fold increase in the odds of reporting a fire station BP check. These findings support our first hypothesis that participants who received any mailing (intervention group) would be more likely to visit a local fire station for a BP check than participants who did not receive a mailing (control group). There were no significant differences between the different communication conditions (i.e. perceived risk or EMT personalization) in reporting a fire station BP check. Process data (not shown) indicate that 59% of interviewees who responded to the long survey form in the intervention arms remembered receiving the mailing and of those 74% reported they were "Very" (49%) or "Somewhat" (25%) surprised by the mailing. Older participants were more likely to report visiting a fire station for a BP check than younger ones.

Characteristics of participants who visited a fire station for a BP check

The 128 participants who reported going to a fire station for a BP check during the study interval differed from the other interviewed cases as they were significantly older, average 68.3 (SD 16.9) years of age compared to 63.7 (SD 18.2) years of age ($p = 0.005$). No other demographic differences were observed: gender, health insurance, marital status, income, educational attainment, race and ethnicity, presence of others in the household, and language spoken at home.

Table 2
Baseline characteristics of eligible participants by interview status (N = 7106).[a]

	Interviewed (n = 2889)	Not interviewed (n = 4217)	p-value
Fire department, row% (n)			<0.0001
Agency 1	42.5 (458)	57.5 (619)	
Agency 2	44.0 (894)	56.0 (1137)	
Agency 3	35.7 (623)	64.3 (1123)	
Agency 4	40.6 (914)	59.4 (1338)	
Randomization assignment, col% (n)			.195
Control	20.5 (592)	20.1 (848)	
No source & generic risk	18.4 (532)	20.7 (872)	
Source & generic risk	20.5 (592)	20.3 (854)	
No source & tailored risk	20.0 (578)	19.6 (826)	
Source & tailored risk	20.6 (595)	19.4 (817)	
Male gender, col% (n)	38.6 (1114)	43.4 (1829)	<0.0001
Age (years), mean ± SD			
Men	59.8 ± 18.7	57.2 ± 20.0	.001
Women	66.5 ± 17.3	65.2 ± 19.6	.02
Total	63.9 ± 18.2	61.7 ± 20.2	.000
Patient location when seen by EMS, col% (n)			.113
Home or residence	72.2 (2085)	70.5 (2970)	
Other place	27.8 (803)	29.5 (1245)	
Patient problem recorded by EMS, col% (n)	.002		
Fall	12.1 (341)	11.1 (443)	
Motor vehicle accident	5.4 (152)	6.0 (240)	
Other trauma	5.2 (145)	7.0 (281)	
Cardiovascular	9.2 (257)	6.9 (277)	
Respiratory	7.2 (202)	7.3 (291)	
Neurologic	14.7 (412)	15.2 (609)	
Abdominal, genitourinary	8.7 (244)	9.0 (361)	
Metabolic or endocrine	3.6 (102)	3.2 (129)	
Other medical problem or illness	22.9 (644)	21.5 (859)	
Psychiatric	6.2 (173)	7.0 (280)	
Alcohol or drug related	3.1 (87)	3.8 (154)	
Other	1.7 (49)	2.0 (79)	
Outcome following EMS event, col% (n)			
Patient remained at scene	23.8 (687)	22.3 (942)	.166
Transported by private vehicle/taxi	6.9 (200)	6.3 (266)	
Transported by ambulance	69.3 (2000)	71.3 (3007)	
Number of times EMS found patient with high blood pressure during study interval, col%(n)			<0.0001
Once	84.9 (2454)	88.7 (3740)	
More than once[b]	15.1 (435)	11.3 (477)	
Apparent good mailing address[c], col% (n)	97.4 (2238)	96.7 (3257)	.103
Days from EMS encounter to mailingc, mean ± SD	32.7 ± 14.0	34.2 ± 13.0	<0.0001
Apparent good phone number for telephone interview, col% (n)	100.0 (2889)	74.2 (3127)	<0.0001
Days from EMS encounter until first interview attempt, mean ± SD	75.8 ± 22.8	77.3 ± 21.3	<0.0001

[a] The study took place in four fire districts in a metropolitan area in the Pacific northwest from July 2007 through September 2009.
[b] Patients not enrolled again on subsequent EMS calls.
[c] For intervention groups (not control).

Other locations for BP screening

To explore if the intervention affected BP screening at other locations than a fire station we compared self-reported BP check location between intervention and control participants. The only difference for the reported BP check location was that the controls were less likely to check their BP at a fire station. There were no differences among the study arms in checking at a clinic or doctor's office, a pharmacy, by home monitor, or at another place. The most common other places

Table 3
Modeling the proportions of subjects who visited a fire station for a BP check after their 911 event (n = 2889)[a].

	Adjusted odds ratio[b]	95% CI	p-value
Study arm			.001
Control (ref.)	1.0		
No source, generic risk	5.41	2.48–11.81	
No source, tailored risk	3.17	1.41–7.13	
Source, generic risk	4.20	1.91–9.21	
Source, tailored risk	3.83	1.73–8.47	
EMT source visual			0.001
Control (ref.)	1.0		
No source	4.21	1.99–8.87	
Source	4.02	1.91–8.46	
Tailored BP risk report			<0.001
Control (ref.)	1.0		
Generic risk	4.76	2.27–9.99	
Tailored risk	3.50	1.65–7.42	
Fire department[c]			0.034
Agency 1 (ref.)	1.0		
Agency 2	0.50	0.30–0.82	
Agency 3	0.54	0.31–0.94	
Agency 4	0.61	0.37–0.99	
Age (years)[c]			0.008
18–49 (ref.)	1.0		
50–64	1.47	0.81–2.66	
65–79	1.54	0.86–2.76	
≥80	2.50	1.43–4.39	
Gender[c]			0.126
Female (ref.)	1.0		
Male	1.33	0.92–1.93	

[a] The study took place in four fire districts in a metropolitan area in the Pacific Northwest from July 2007 through September 2009.
[b] Adjusted for fire department, age, gender.
[c] Covariate odds ratios, 95% CIs, and p-values reported from analysis of 5 study arms.

overall included at a hospital or emergency room, at work, or by a nurse's aide in an assisted living setting.

Discussion

The objective of this trial was to test the effectiveness of an EMS mail campaign to motivate high-risk patients identified by emergency responders to go to a local fire station to get a repeat BP check. The results show that although the absolute number of patients who reported a fire station BP check was low (4%), receiving any brochure led to a 3 to 5-fold increase in the odds of reporting a fire station BP check among eligible intervention subjects compared to the control group.

There were no differences between self-reported BP check received in the past month at a location other than a fire station (around 85% across participants). It is possible that most patients remembered (and referred to) a BP check in the emergency department since almost 80% of participants were transported by the fire department or private ambulance. This could explain the very high percent of people reporting a high BP check as well as the lack of difference between the control and intervention groups.

There were no differences in self-reported fire station BP checks between the different tailoring methods. However, participants reported being surprised by the mailing, which might have increased motivation to process the message content, thereby diluting the effect of the tailoring and source personalization manipulation.

Older people were more likely to visit a fire station for a BP check than younger people. This is encouraging in that older individuals are more likely to have other chronic conditions that make hypertension control even more clinically important.

Limitations of the study

Although the results of this trial showed receiving a brochure led to a 3 to 5-fold increase in the odds of reporting a fire station BP check there are some limitations to the study that need to be addressed.

The intervention is limited as it only addresses the first step in hypertension control—screening community members with uncontrolled hypertension and encouraging BP monitoring. The barriers to obtaining appropriate hypertension care still need to be addressed. Additionally, the outcome variable is limited in that it only measures participants' self-report of a fire station BP check. It is possible that participants who received and were surprised by the mailing may have said yes because of the social desirability of an affirmative response. Where possible, fire stations validated fire station BP checks.

The reach of the intervention was large in scope although about one-third of potentially eligible patients were excluded due to lack of contact information on the MIRF. It is likely that these patients might be more transient, homeless, and less connected to the health care system. Our intervention did not reach this group. Of the more than 7000 eligible patients who were randomized to our intervention, less than half were reached by telephone for a follow-up interview. Again, lack of complete and accurate contact information made it impossible to reach a large number of community members. There are many reasons why contact information is difficult to get from the MIRF, including 1) cell phones, 2) a phone number listed for someone other than the patient, 3) error in recording the number on the MIRF or data entry error, 4) too busy with other acute care activities to write down the number or enter it into the electronic database, or 5) no phone number available. The participants who were not interviewed were younger, less likely to be at home, and more likely to be male compared to those who were interviewed. This suggests that younger men seen by EMS are less likely to have accurate and complete contact information, possibly due to the more transient situation of younger men.

These difficulties made it challenging to reach all eligible community residents at risk for uncontrolled hypertension with both the intervention and the evaluation. Because this trial was randomized, the results are still encouraging in that participants who were reached by the mailing were more likely to take the recommended action than those who did not receive the mailing.

Conclusion

This trial showed that community residents who call 911 will respond to a mailing about their BP. However, only a very small fraction of the study group actually visited a fire station in response to the campaign (about 5% of the study population). Although the effect size was small, the potential number of people that could be reached by the intervention was large as over 10,000 patients seen by EMS for a non-life-threatening medical issue in the four participating fire districts had very high BP values during our study period.

Since this study was completed the content of the mailing has been added to a patient information sheet that is attached to the MIRF. EMTs throughout King County, Washington can use this sheet to write down a patient's BP values, discuss the importance of BP monitoring, and hand it to the patient at scene. Providing this information at scene reduces the labor and cost of sending this information in the mail, as was done for this study. An evaluation of this at-scene patient education intervention is currently underway.

Due to the high penetration of EMS in most communities, there is a novel potential for population health interventions using EMS to identify and refer high-risk individuals. Thousands of people are visited by EMS every year; many are found to have undiagnosed or uncontrolled chronic diseases that put them at risk for life-threatening events. Investigating ways in which to effectively follow up with these patients is a challenge and more research is needed to capitalize on this potential and develop strategies to motivate at risk community residents to take action.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest. This randomized controlled trial was registered at clinical trials.gov (NCT00495833); registration date: June 29th, 2007 as the SPHERE Hypertension Intervention Study. IRB approval for the study was obtained on 6/17/2007. The funding source had no role in study design, data collection, analysis, or interpretation.

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