Original Research

Assessing hypertension control in the community: the need for follow-up measurements to ensure clinical relevance

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In community surveys of hypertension control the diagnosis is often based on blood pressure measurements taken on only one visit. The clinical diagnosis of hypertension requires demonstration of sustained blood pressure elevation. We conducted a survey that contrasted the results of these two approaches to determining the prevalence of hypertension and the extent to which hypertension is detected and treated. A multistage random sample of 2737 people was selected, examined and interviewed on up to three occasions. Rates of hypertension prevalence and control were computed from data from one, two and three visits. The prevalence of hypertension was overestimated by 30% when the diagnosis was based on data from one rather than three visits, the rates being 149 and 115/1000. The prevalence of undetected hypertension was overestimated by 350%, the rates being 27 and 6/1000. The proportion of subjects with controlled hypertension was underestimated by 23%, at 56%, compared with 73%. These results confirm the need for follow-up measurements to provide a valid assessment of hypertension control in the community.

Dans le cadre des enquêtes de dépistage de l'hypertension dans la communauté, le diagnostic est souvent fondé sur des mesures de tension artérielle qui n'ont été prises qu'à l'occasion d'une seule visite. Par contre, dans le cas du diagnostic clinique de l'hypertension, il faut démontrer une élévation soutenue de la tension artérielle. Nous avons comparé les résultats de ces deux méthodes et les degrés auxquels elles permettent de détecter et traiter l'hypertension. Nous avons choisi au hasard un échantillon échelonné de 2737 personnes que nous avons examinées et interviewées jusqu'à trois reprises. Les taux de prévalence et de maîtrise de l'hypertension ont été calculés à partir de données recueillies à l'occasion d'une, de deux et de trois visites. Lorsque le diagnostic était fondé sur des données recueillies à l'occasion d'une visite plutôt que de trois, la prévalence de l'hypertension était surestimée de 30%, les taux respectifs étant de 149 et 115/1000. La prévalence de l'hypertension non détectée a été surestimée de 350%, les taux étant de 27 et de 6/1000. La proportion des sujets dont l'hypertension était maîtrisée a été sous-estimée de 23%, c'est-à-dire à 56% par comparaison à 73%. Ces résultats confirment que les tests de surveillance sont nécessaires à la lutte contre l'hypertension dans la communauté.

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The efficacy of the treatment of patients with elevated blood pressure has been well established in randomized clinical trials.[1-5] However, there continues to be substantial debate about the diagnostic criteria that should be used to determine which people should be treated with

← For prescribing information see page 611

antihypertensive drug therapy. In 1976 the Ontario Council of Health suggested that treatment should be based on demonstration of sustained elevation of diastolic blood pressure since entry criteria based on sustained diastolic elevation had been used in all efficacy trials.[6] The council recommended treatment of all people with sustained diastolic pressure over 104 mm Hg and all people with sustained diastolic pressure between 90 and 104 mm Hg if they had signs of target organ damage. Finally, it was recommended that clinical judgement be used to decide about treatment for people with blood pressure levels not corresponding to these limits. The Canadian Hypertension Society's consensus conference on the management of mild hypertension recommended in 1984 that the treatment level be reduced to 100 mm Hg.[7] Similar recommendations based on somewhat lower diastolic pressures have been made in the United States.[8]

Currently there is considerable interest in developing and implementing community-based programs to increase hypertension control in Canada. Before a new intervention program is designed, it is important to determine how physicians in the target community are doing in detecting and controlling hypertension. The most common method of evaluating hypertension prevalence and control is a cross-sectional survey in which blood pressure measurements are obtained at only one visit. However, most clinicians diagnose hypertension on the basis of a series of blood pressure readings taken over several visits. Hence, evaluations based on one visit could produce a biased view of the success of community physicians in detecting and treating hypertension. It is well accepted that the prevalence of hypertension decreases with repeat visits. For example, in the Australian Therapeutic Trial in Mild Hypertension 37% of people who initially met a screening criterion of diastolic blood pressure over 95 mm Hg were found to have a diastolic pressure of 95 mm Hg or less 2 weeks later.[3] It has been suggested that this is due to a combination of two factors: regression to the mean[9,10] and patient familiarity with the diagnostic process, although recent evidence does not support the second factor.[10]

The purpose of this report is to describe the effect of follow-up visits on estimates of hypertension prevalence and control.

Methods

We conducted a community-based hypertension control survey from September 1981 to October 1982 in Middlesex County, Ontario. The target population was all noninstitutionalized people over the age of 18 years. Details of the survey methods have previously been published.[11] Briefly, we selected a three-stage stratified probability sample such that all people in each of our six strata had the same probability of being selected for inclusion in the sample. In total, 1500 households were selected, and 3067 people were eligible for interview.

The interview was conducted in the home at a time convenient to the respondent. It consisted of administration of a questionnaire (which took 10 to 15 minutes), followed by three blood pressure measurements with an updated version of the Hawksley random zero sphygmomanometer.[12] All the interviewers were trained and tested in blood pressure measurement technique to ensure standardization of measurement.[13] Fifth-phase diastolic pressure was used. When fifth-phase pressure was not detected, fourth-phase pressure was recorded and a special notation made. All blood pressure measurements were taken on the right arm, with the subject sitting quietly and not smoking. One of three different-sized cuffs was selected, depending on arm circumference.

Subjects whose minimum diastolic blood pressure exceeded 89 mm Hg at the initial interview had a second visit about 1 week later, and the series of blood pressure measurements was repeated. If their minimum diastolic blood pressure was above 89 mm Hg at this visit, a third visit was carried out about 1 week later. At both follow-up visits subjects were asked whether they had begun or changed any antihypertensive treatment.

Subjects were considered to be hypertensive if they either had a minimum diastolic blood pressure of over 89 mm Hg at the third visit or stated that they were receiving treatment for hypertension, regardless of their blood pressure. Treatment could consist of either drug or nondrug therapy (e.g., low-salt diet, or weight or stress reduction).

Minimum blood pressure was used as the basis for the diagnostic criteria since it has been shown to be similar to mean blood pressure in its diagnostic properties[14] and is easy to use in clinical practice.

The identified hypertensive subjects were classified into four groups on the basis of previous detection and treatment status. The "undetected" group comprised people with elevated blood pressure at the third visit who denied having been informed that their blood pressure had been elevated in the past. The "untreated" group comprised people with elevated blood pressure at the third visit who were aware of their condition but did not report receiving any treatment. The "uncontrolled" group comprised people who were receiving treatment but whose three diastolic blood pressure readings at the initial visit all exceeded 89 mm Hg. The "controlled" group comprised people receiving treatment who had at least one diastolic blood pressure reading under 90 mm Hg at the initial visit.

We calculated separate estimates of prevalence and control rates from data from one, two and three visits. Treatment and control were defined from data collected at the first visit in all three cases. Thus, a person who at the initial interview

reported receiving treatment and whose diastolic blood pressure was 96 mm Hg at that interview and 88 mm Hg at the second would be classified as "uncontrolled" for all three analyses. Estimates of prevalence and control were calculated with formulas adopted from standard sampling theory.[15] Point estimates were adjusted to reflect the sample selection process. The standard error of ratio estimates was obtained by means of a Taylor series expansion. All calculations were done with the computer package SUPER CARP.[16] When appropriate, raw data are presented to document sample size. However, since all rates and proportions were calculated with adjustment as described here, they would not necessarily match the simple rates that could be calculated directly from the raw data.

Results

Of the 3067 people eligible for interview 2737 completed the initial interview, a response rate of 89.2%. Of the 181 subjects eligible for the first follow-up visit 10 refused, and of the 75 eligible for the second follow-up visit 4 refused; the overall response rate for the two follow-up visits was 94.6%. Of the 14 people who refused follow-up 8 were known to be hypertensive and to be receiving treatment and were thus classifiable in all the analyses. This gave a classification rate for the follow-up visits of 97.7%. The sample was 46.3% male and predominantly white (Table I).

Six subjects had a change in their treatment status between the initial visit and the first follow-up visit, and seven others had a change between the first and second follow-up visits. Of these 13 subjects 8 were already receiving therapy, and 3 had previously been treated and had diastolic blood pressure readings around 100 mm Hg. One subject with undetected hypertension whose initial diastolic blood pressure was 100 mm Hg was started on treatment after the initial visit. The remaining subject had previously received treatment and had a diastolic blood pressure of around 90 mm Hg at both the initial visit and the first follow-up visit. Thus, changes in treatment between visits affected the classification of only five subjects (0.2% of the sample), and in only two cases did the change occur in subjects whose hypertension status was doubtful.

The prevalence rate of hypertension determined only on the basis of information obtained at the initial visit was 149/1000 (Table II, Fig. 1). With data from two visits the rate was 122/1000, and with data from three visits it was 115/1000. The standard error of each of these estimates was approximately 7/1000. Overall, the prevalence of hypertension was overestimated by 30% when the diagnosis was based on only one visit.

The prevalence rates of undetected hypertension were 27/1000 when the diagnosis was based on only one visit, 9/1000 with data from two visits and 6/1000 with data from three visits (Table II, Fig. 1). Thus, the prevalence of undetected hypertension was overestimated by 350% when the diagnosis was based on only one visit. A similar pattern was seen for the prevalence of untreated hypertension: the rates were 21/1000 with data from one visit and 7/1000 with data from three visits, an overestimate of 300%. The prevalence of treated hypertension (either controlled or uncontrolled) was not altered by the number of visits since this diagnosis was established by self-reported information provided at the first visit.

The proportions of hypertensive subjects clas-

Table I — Sociodemographic characteristics of 2737 subjects in survey of hypertension

Characteristics	No. (and %) of subjects
Sex	
Male	1268 (46.3)
Female	1469 (53.7)
Race	
White	2672 (97.6)
Black	17 (0.6)
Other	48 (1.8)

Table II — Estimated prevalence rates of hypertension per 1000 based on data from one, two or three visits*

Category	One visit		Two visits		Three visits	
	No. (and %) of subjects	Rate (and 95% confidence limits [CL])	No. (and %) of subjects	Rate (and 95% CL)	No. (and %) of subjects	Rate (and 95% CL)
Normotensive	2326	851 (836, 866)	2398	878 (864, 892)	2415	885 (872, 898)
Hypertensive	409	149 (134, 164)	333	122 (108, 136)	314	115 (102, 128)
Undetected	77 (18)	27 (20, 34)	27 (8)	9 (5, 13)	16 (5)	6 (3, 9)
Detected but untreated	51 (14)	21 (16, 36)	25 (8)	10 (6, 14)	17 (6)	7 (4, 10)
Treated but uncontrolled	53 (13)	19 (14, 24)	53 (16)	19 (14, 24)	53 (17)	19 (14, 24)
Treated and controlled	228 (56)	83 (71, 95)	228 (68)	83 (71, 95)	228 (72)	83 (71, 95)
Unclassifiable	2		6		8	

*The prevalence rates and the percentages of subjects in this table and Table III were estimated from adjusted data.

sified into each of the four categories (undetected, untreated, uncontrolled and controlled) were also estimated. With data from the initial visit, 18% of the subjects were classified into the undetected group (Table II, Fig. 1). The proportions were 8% after two visits and 5% after three visits. The proportion of untreated hypertensive subjects decreased from 14% to 5% with data from three visits. There was a slight rise in the proportion of subjects with uncontrolled hypertension, from 13% to 17%. The proportion of subjects with controlled hypertension rose from 56% to 72%.

In these analyses a diastolic blood pressure of 90 mm Hg was used to diagnose hypertension. The effect of follow-up visits on prevalence rates when levels of 95 and 100 mm Hg were used as the diagnostic criteria was similar to that found with the criterion of 90 mm Hg (Table III). The effect of follow-up visits was less marked owing to the lower prevalence of untreated hypertension.

Discussion

Our results show the biases that may be introduced if a clinically credible diagnosis based on sustained elevation of blood pressure is not used in a project to evaluate hypertension control. As in other studies,[3,9,17] the prevalence of hypertension was overestimated (by 30%). The prevalence rates of undetected and untreated hypertension were more markedly overestimated, by around 300%. There was also a marked bias in estimates of the proportions of hypertensive subjects in each treatment category. Nearly 80% of the subjects classified into the undetected group at the initial visit were reclassified as normotensive after follow-up visits. These biases could affect the design of new blood pressure control programs: the results from the initial visit suggest that physicians in Middlesex County are failing to identify and treat a large proportion of the hypertensive people in the community and that a new community-based screening program might be useful. However, the data from all three visits show that, overall, hypertension control is good, but problems with starting optimal treatment and patient compliance may hinder even better hypertension control.

The changes in treatment status in our study are what would be expected from theoretical considerations. The initial visit allows all hypertensive people receiving treatment to be identified and classified as having controlled or uncontrolled hypertension. However, the number of people with undetected or untreated hypertension declines with follow-up since some of them are reclassified as normotensive owing to regression to the mean[9,10] or increased patient familiarity with the diagnostic process. Hence, the denominator for all four proportions decreases, and the numerator for the rates of undetected and untreated hypertension greatly declines, so that these rates decrease. In contrast, the numerator for the rates of uncontrolled and controlled hypertension are unchanged, so that these rates increase.

The follow-up strategy that we used allowed

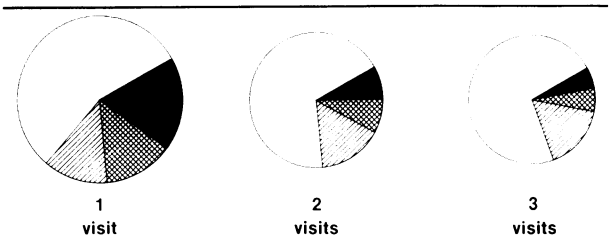

Fig. 1 — Proportions of hypertensive subjects in four treatment categories based on data from one, two or three visits. Black area = undetected; hatched area = detected but untreated; lined area = treated but uncontrolled; white area = treated and controlled. Diameter of charts is proportional to prevalence of hypertension.

Table III — Estimated prevalence rates of hypertension per 1000 based on data from one, two or three visits with a diagnostic diastolic blood pressure of 95 or 100 mm Hg

Diagnostic diastolic blood pressure; category	One visit		Two visits		Three visits	
	No. (and %) of subjects	Rate	No. (and %) of subjects	Rate	No. (and %) of subjects	Rate
95 mm Hg	331	121	303	111	297	108
Undetected	27 (7)		10 (3)		6 (2)	
Detected but untreated	23 (7)		12 (5)		10 (4)	
Treated but uncontrolled	53 (16)		53 (17)		53 (18)	
Treated and controlled	228 (69)		228 (75)		228 (77)	
100 mm Hg	309	113	293	106	287	104
Undetected	13 (4)		6 (2)		3 (1)	
Detected but untreated	15 (5)		6 (2)		3 (1)	
Treated but uncontrolled	53 (17)		53 (18)		53 (18)	
Treated and controlled	228 (73)		228 (78)		228 (80)	

identification of false-positive results (i.e., incorrect identification of people as hypertensive). There is also a potential problem with false-negative results (as when people are hypertensive but are not so diagnosed by the study). Since self-reporting of hypertension treatment has been shown to be highly accurate,[17,18] the main potential source of false-negative results was people whose diastolic blood pressure was below 90 mm Hg at the first visit but may have been higher at subsequent visits. This rate cannot be directly estimated from our survey since the relevant group was not revisited. However, we have clinical and research evidence that the problem of false-negative results was likely not large.

Clinically, people are treated for hypertension if they have sustained elevation of blood pressure. If the diastolic blood pressure is under 90 mm Hg at the first visit, it is highly unlikely that subsequent blood pressure readings would lead to initiation of treatment. Furthermore, most clinicians are unlikely to repeat the blood pressure measurement in such people. Such patients may receive closer follow-up in subsequent years and may be candidates for programs to prevent the development of sustained elevation of diastolic blood pressure.

Research evidence also suggests that blood pressure is much more likely to be lower than to be higher at follow-up visits.[19,20] We examined our data to determine the probability that blood pressure would be higher at follow-up visits in people with initial diastolic levels of 90 to 95, 96 to 100 and 101 to 105 mm Hg. In all cases only about 5% of the group moved into a higher category. Extrapolating this figure to the group whose initial diastolic blood pressure was 85 to 89 mm Hg, we estimate that the number of hypertensive subjects would be increased by about 10 (3%). Since some of these subjects would be receiving treatment and hence would already be included in the hypertensive group, the effect on prevalence and control rates would be small.

Some concern was raised by reviewers of an earlier version of our paper that the definition of controlled hypertension was based on the results of only one visit even though subjects with uncontrolled hypertension (initial diastolic blood pressure over 89 mm Hg) received follow-up visits. This group was followed to simplify project administration and for other analyses. This follow-up information could have been incorporated into the definition of control; the effect would have been a decrease in the prevalence of uncontrolled hypertension and an increase in the proportion of subjects with controlled hypertension. However, we believe that the approach we adopted is clinically relevant since blood pressure should be controlled at all visits.

How many visits should be used in community blood pressure surveys? This issue has been addressed in a number of theoretical papers[19,20] and by consideration of empirical evidence. Most groups agree that it is more important to obtain readings from several visits than to increase the number of readings at each visit. After reviewing all the available evidence the consensus conference on the management of mild hypertension recommended at least four visits over at least 6 months for use in clinical practice.[7] While such a long follow-up interval is appropriate for the clinical decision process, it is not practical for community surveys. Extrapolation of our data suggests that estimates based on three visits over 3 weeks would be somewhat biased compared with results obtained according to the recommended clinical standard but that the bias would be small.

We have concentrated in this paper on estimates of prevalence and control rates based on a diagnostic diastolic blood pressure of 90 mm Hg, but we have presented estimates based on levels of 95 and 100 mm Hg. There is a problem in interpreting data based on diastolic levels above 94 mm Hg since we could not obtain blood pressure readings without treatment for people already receiving antihypertensive treatment. Data from a random survey of physicians in the target area indicated that most would begin some form of treatment (either drug or nondrug) if the diastolic blood pressure were consistently between 95 and 99 mm Hg, and many would begin treatment if the pressure were between 90 and 94 mm Hg.[21] Hence, if a diagnostic level of 95 or 100 mm Hg were used, a large but unknown proportion of people would be classified as hypertensive because they were receiving treatment, but they would have blood pressure readings without treatment that would not meet the diagnostic criterion. This would tend to overestimate the prevalence of hypertension and underestimate the proportion of people with undetected hypertension. Therefore, the data on the effect of follow-up visits on estimates for diagnostic levels of 95 and 100 mm Hg should be interpreted with caution.

Do our results suggest that there is no role for blood pressure surveys in which measurements are obtained at only one visit? In our opinion such an interpretation is unwarranted. Single-visit blood pressure readings have been shown to be a good indicator of the risk of cardiovascular disease and stroke.[22] If the goal of a survey is to establish a community risk profile, single-visit blood pressure surveys are appropriate. However, in light of the large biases we have identified, evaluations based on single visits would be inappropriate for surveys to identify people who would benefit from antihypertensive treatment and to evaluate the success of physicians in detecting and treating hypertension.

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Meetings

continued from page 576

May 24-27, 1987

The Foundations of Management, Physician Manager Institute
Niagara Institute, Niagara-on-the-Lake, Ont.
Mr. Chuck Shields, Canadian College of Health Service Executives, 201-17 York St., Ottawa, Ont. K1N 5S7, (613) 235-7218, or Mr. Joe Chouinard, Canadian Medical Association, PO Box 8650, Ottawa, Ont. K1G 0G8, (613) 731-9331

May 25-June 12, 1987

Organization and Delivery of Health Services in Britain
King's Fund College, London
Dr. Rhonda Cockerill, Health Care Research Unit, Department of Health Administration, University of Toronto, 150 College St., Toronto, Ont. M5S 1A1; (416) 978-6963

May 27-30, 1987

Symposium on Diet, Nutrition and Health
University of Western Ontario
Dr. K.K. Carroll, Department of Biochemistry, University of Western Ontario, London, Ont. N6A 5C1; (519) 661-3096 or 661-3097

May 28-30, 1987

Leadership Skills Development, Physician Manager Institute
Niagara Institute, Niagara-on-the-Lake, Ont.
Mr. Chuck Shields, Canadian College of Health Service Executives, 201-17 York St., Ottawa, Ont. K1N 5S7, (613) 235-7218, or Mr. Joe Chouinard, Canadian Medical Association, PO Box 8650, Ottawa, Ont. K1G 0G8, (613) 731-9331

May 29-31, 1987

87th Annual Conference of the Canadian Lung Association
Queen Elizabeth Hotel, Montreal
A. Les McDonald, director, Health Education & Program Services, Canadian Lung Association, 908-75 Albert St., Ottawa, Ont. K1P 5E7; (613) 237-1208

June

June 3-5, 1987

Knee Surgery Update 1987
Mount Sinai Hospital, Toronto
Ms. Sandra Leith, administrative coordinator, Continuing Education, Faculty of Medicine, Medical Sciences Building, University of Toronto, Toronto, Ont. M5S 1A8; (416) 978-2718

continued on page 616