Original Article

How to help patients to control their blood pressure? Blood pressure control and its predictor

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ABSTRACT

Introduction: Good blood pressure (BP) control is one of the aims of hypertension disease management. Consistently achieving the targeted BP could reduce patient's risk of developing the complication of hypertension.

Materials and Methods: This study is a prospective cohort study aimed to investigate the blood pressure reading among in patients in a public tertiary hospital in northern Malaysia and to determine predictor of good BP control among patients. Patients were followed from their admission day until discharge. Data were collected by the researcher from the medical records. Information collected were BP reading on admission, day 1 and discharge. Other information includes demographic data, social factors, medication name and number, co-morbidities, target organ damage, cardiovascular risk factors. Descriptive analysis was done to determine the characteristic of patients and logistic regression was done to identify factors associated with BP control.

Results: A total of 400 patients were followed up from admission till discharge. BP was controlled in 24% on admission and in 54% of patients on discharge. Multivariate analysis on admission revealed that the predictors of BP control were the use of diuretics and statin. Factors identified to be associated with poor BP control were diabetes mellitus, cerebrovascular disease and retinopathy. Multivariate analysis on discharge showed that the predictors of good BP control were diuretics and beta-blockers and the predictors of poor BP control were diabetes, chronic kidney disease, diabetic nephropathy, cerebrovascular disease and number of comorbidity.

Conclusion: These results demonstrated that hypertension was poorly controlled among in-patients and that BP control was better on discharge than on admission. Patients with diabetes mellitus, renal disease and cerebrovascular disease were more likely to have poor hypertension control.

Key words: Blood pressure monitoring and measurement, cardiovascular disease, diabetes complications

INTRODUCTION

Hypertension is a major cardiovascular risk factor. Hypertension treatment and control is important to prevent cardiovascular morbidity and mortality.[1]

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Epidemiological survey showed that hypertension is highly prevalent among the population. Interestingly, the high prevalence of hypertension is associated with an incorrect perception about hypertension, low treatment rate and poor BP control.[2,3] In US, approximately 22.7 million patients with hypertension are not treated and more than 50% of patients with hypertension being actively treated require additional clinical interventions to achieve recommended BP targets. According to the recent AHA information (2005-2006), 29% of adults 20 years and older have uncontrolled hypertension. Of these, 79% are aware of their condition, and 68% are

receiving treatment. However of those treated, only 64% received therapies that achieve the recommended evidence-based BP goals.[4,5]

Many of studies had shown that patients commonly do not seek treatment for their condition, nor do they adhere to their treatment plans because of the asymptomatic nature of hypertension.[6,7] In fact, the US health care system has historically been driven by disease management rather than disease prevention; thus, asymptomatic conditions such as hypertension are often inadequately addressed.[8] In Malaysia, the National Health and Morbidity Survey reported that only 33% of hypertensive individuals were aware of their hypertension condition. Out of the 33%, 23% received hypertension treatment and hypertension was control in only 6% of the patients receiving treatment.[9] To further illustrate the seriousness of the problem, other similar studies also showed the low rate of BP control.[10-12]

A survey of 1,392 respondents, age 55 years and older in Kuala Lumpur revealed that 24.1% had been previously diagnosed as hypertensive, and 82.1% of them were on treatment. However, only 48.1% of them had controlled hypertension.[13] A study of 100 hypertensive out-patients in a tertiary hospital in northern Malaysia addressed the health status of hypertension through an interview-administered questionnaire. The study found that only 62% had a controlled BP.[14] A study of sixty hypertensive inpatients who had been admitted to the medical ward and who had dropped out of treatment before admission (all of them were noncompliant) showed that only one patient had controlled hypertension.[9] Another study of 108 hypertensive patients admitted with cardiovascular complications showed that all the patients had uncontrolled hypertension on admission and that 22% were newly diagnosed, and 56% of the previously diagnosed had dropped out of treatment. These data showed that BP is poorly controlled among hypertensive patients in the community and hospitals.

Thus, studies on hypertension control are needed to determine the predictors of poor BP control. From the literature survey, it was found that most of the studies were done on outpatients setting[15-19] whereas few were done on inpatients setting.[12,20] To the best knowledge of the authors, in-patient's studies can provide with more information on BP control. It is because patient, often presented with other co-morbidities needs to be stabilized inward for acute BP control.[18,21,22] Furthermore, outpatient-based clinics often lack an organized system of regular follow-up and review of their hypertensive patients, whereas in-patient and ward setting could monitor closely antihypertensive drug therapy using a more intensive stepped care approach in order to reach target BP levels.[23] Thus, the aim of this study is to evaluate BP control in hospitalized patients and to identify the factors associated with hypertension control.

MATERIALS AND METHODS

Research design

This is a prospective observational study. The data were collected over a period of 9 months (October 2004 to July 2005). All patients admitted to medical wards with high BP were prospectively followed from admission until discharge. The study was carried out in Penang General hospital which is the main government hospital in the state. Data were collected from three medical wards, which were general medicine, endocrinology, and cardiology wards. There are 35 beds in each ward.

Identification of the cases and study population

Every new admission was recorded by a nurse in a registration book. Information entered includes the name, ethnicity, primary diagnosis and other concurrent diagnosis, the bed number and the medical record number. This book was used to identify newly admitted patients. The diagnosis of hypertension for each patient was verified by reviewing the medical records because the diagnosis of hypertension was not always written down in the registration book. This is especially true for patients whose primary reason for admission was not hypertension. Patients who were admitted consecutively to the three medical wards with diagnosis of hypertension during the study period (9 months) were included. Patients with more than one admission during the study period were analyzed for the first admission only.

Approval of the study and sampling procedure

The approval of the study was obtained from the clinical research committee of the hospital. The identity of the patients was anonymonized, and strict confidentiality was ensured. A consecutive convenient sampling was adopted. All hypertensive patients admitted to the medical wards during the study period who fulfilled the inclusion criteria were included in the study. Inclusion criteria are patients who were admitted more than One day to medical wards in Penang Hospital with a confirmed diagnosis of hypertension. The patient must be at least 18 years

old and less than 90 years old. Patients must be willing to participate in the study. Patients diagnosed with secondary hypertension or pregnancy induced hypertension and critically ill-patients (admitted to Intensive Care Unit, Cardiac Care Unit and dialysis unit) were excluded.

Data collection

Data were collected by the researcher utilizing a special data collection form. Informed consent was obtained from each patient. The medical record for every patient admitted to medical wards was reviewed to confirm the diagnosis of hypertension. Eligible patients were given a serial number according to their admission sequence. Sociodemographic and clinical data were obtained from the medical records. The sociodemographic data includes detail about ethnicity, age, gender, marital status, working status, education level, monthly income, smoking habits, and alcohol consumption. On the other hand, clinical data includes BP readings in the casualty department, at time of admission to the ward and daily readings until discharge, the heart rate for each BP reading, risk factors for cardiovascular disease, medications given before admission and at discharge and family history of hypertension.

Definitions of blood pressure status

In this study, JNC 7 criteria were used to classify BP as controlled or uncontrolled. It is considered controlled if the reading is less than 140/90 mmHg for patients without diabetes mellitus and/or chronic renal disease. For patients with diabetes and/or chronic renal disease, the criteria were 130/80 mmHg. For patients with chronic renal disease with proteinuria of > 1 g/day, the criteria were set at 125/75 mmHg.[8] JNC 7 recommended a treatment threshold of 140/90 mm Hg regardless of age,[8] whereas JNC 8 raises the systolic threshold at age 60.[24] In addition, JNC 7 recommended a lower treatment threshold (130/80 mm Hg) for patients with diabetes or chronic kidney disease, but JNC 8 does not. In JNC 7, thiazide-type diuretics were recommended as initial drug therapy (unless compelling reasons dictated another drug class), with calcium-channel blockers (CCBs), angiotensin-converting enzyme inhibitors (ACEI), angiotensin-receptor blocker (ARBs), and β-blockers as alternates. In JNC 8, the initial drug choice is broadened to four classes for nonblack patients and two classes for black patients. B-blockers are no longer recommended for initial therapy because they might afford less protection against stroke.[24]

For one, an expert writing group recommends a relaxing of the more aggressive JNC 7 target BPs and treatment-initiation thresholds in elderly patients and in patients under age 60 with diabetes and kidney disease.[8] JNC 8 also backs away from the recommendation that thiazide-type diuretics should be initial therapy in most patients, suggesting an ACEI, ARB, CCB, or thiazide-type diuretic are reasonable choices.[24]

Data classification

Some variables were reentered by classification into other categories. Age was reentered according to age group set at 10 years interval. Medications were first entered according to their class and then reentered by names. The number of medications taken was first entered as the actual number and then reentered into 2 categories comprising 2 or more medications versus less than 2 medications.

Data analysis

The relationship between BP control and the characteristics of the patient were analyzed using logistic regression. Descriptive analysis was used to describe the sociodemographic data and the treatment pattern.

Descriptive analysis

Descriptive analysis was used to describe the characteristic of the patients. It was applied to demographic, social and clinical data. The results were expressed in numbers and percentage while mean and standard deviation was used for numerical variables.

Univariate and multivariate analysis

Univariate analysis was used to describe the association between the independent variables and BP control. The crude odds and its 950/0 confidence interval (CI) were calculated for each patient. $P = 0.1$ was considered to be significant. The important clinical and socio demographic variables were introduced together into the multivariate analysis. The backward method was used in the analysis. $P = 0.05$ was considered as significant, and the adjusted odds, and its 95% CI were calculated for each variable.

RESULTS

Characteristic of the study population and blood pressure control

The patient demographic data are presented in Table 1. Meanwhile, the concurrent clinical conditions of the patients studied are presented in Table 2. On admission only 96 patients (24%) had their BP

controlled while on discharge 216 patients (54%) had their BP well-controlled. There was a significant difference in the means systolic blood pressure, diastolic blood pressure, mean arterial blood pressure and pulse pressure on admission, ward and at discharge. A significant difference was found for all parameters [Table 3]. Logistic regression was done to determine the predictors of BP control on admission and discharge. On admission, multivariate analysis showed that diuretic therapy was associated with good BP control. Patients who had no co-morbid disease, cerebrovascular disease, female gender, diabetes mellitus and chronic kidney disease were associated with poor BP control [Table 4]. Multivariate analysis on discharge showed that statin therapy was associated with good BP control. Poor BP control was found to be associated with cerebrovascular disease, diabetic nephropathy, Patients who had no co-morbid disease, diabetes mellitus and chronic kidney disease [Table 5].

Table 1: Sociodemographic characteristics of the study population

Characteristics	*n* (%)
Gender	
Male	194 (48.5)
Female	206 (51.5)
Age group	
25-34	5 (1.6)
35-44	28 (7.0)
45-54	99 (24.8)
55-64	129 (32.3)
65-74	104 (26)
75-84	31 (7.8)
85-94	4 (1.0)
Ethnicity	
Malay	157 (39.6)
Chinese	144 (36)
Indian	98 (24.5)
Others	1 (0.3)
Marital status	
Married	329 (82.3)
Not married	28 (7.0)
Widow	37 (9.3)
Divorced	6 (1.5)
Educational level	
Primary school	206 (51.5)
Secondary school	119 (29.8)
College	5 (1.3)
University	4 (1.0)
No formal education	66 (16.5)
Work status	
Government work	26 (6.5)
Private work	69 (17.3)
Self-employment	29 (7.3)
Retired	98 (24.5)
Housewife	178 (44.5)
Year of diagnosis for hypertension	
Newly diagnosed	22 (5.5)
Less than 1-year	19 (4.8)
From 1 to 10 years	240 (60.0)
From 11 to 20 years	72 (18.0)
From 21 to 30 years	19 (4.8)
From 31 to 40 years	4 (1.0)
Unknown	24 (6.0)

Antihypertensive on admission and discharge

On admission, the most popular antihypertensive agent used across all co-morbidity was beta-blocker. Most of the diabetic patients were on beta-blockers (53.8%) and ACEI (49.32%). For patients with IHD 62.5% were on beta-blockers, and 59.7% of them were on ACEIs. Among those with HF, the highest

Table 2: Concurrent clinical conditions of the patients studied

Variable	*n* (%)
Diabetes mellitus (type I and II)	221 (55.3)
Ischemic heart disease	195 (48.8)
Dyslipidemia	122 (30.5)
No co morbid disease	67 (16.8)
Cerebrovascular disease	66 (16.3)
Chronic kidney disease	61 (15.3)
Smoking	58 (14.5)
Alcohol consumption	45 (11.3)
Congestive cardiac failure	35 (8.8)
Diabetic nephropathy	20 (5.0)
Left ventricular hypertrophy	9 (2.3)

Table 3: Mean BP on admission, day 1 ward and at discharge

	On admission	Day 1 ward	Discharge	*P*
SBP	171.9±39.2	157.5±31.4	137.1±23.4	0.000
DBP	93.5±22.2	90.3±18.6	79.8±13.2	0.000
MAP	120±26.1	113±21.2	99±15	0.000
Pulse pressure	78.4±26.7	67.2±22.4	57.4±18.2	0.000

SBP=Systolic blood pressure, DBP=Diastolic blood pressure, MAP=Mean arterial blood pressure, BP=Blood pressure

Table 4: Multivariate logistic regression on admission

Variable	Odds	95% CI	R^2	*P*
Diuretics	1.972	1.153-3.373	0.145	0.013
Statin	1.536	0.901-2.618	0.150	0.115
Diabetes mellitus (type I and II)	0.522	0. 305-0.892	0.145	0.017
Female gender	0.470	0.282-0.781	0.145	0.004
Chronic kidney disease	0.414	0.0192-0.895	0.145	0.025
Cerebrovascular disease	0.264	0.1-0.697	0.145	0.007
No comorbidity	0.184	0.071-0.476	0.145	0.000
Diabetes nephropathy	0.168	0.021-1.348	0.145	0.093

CI=Confidence interval

Table 5: Predictors of BP control at discharge by multivariate analyses

Variable	Odds	95% CI	R^2	*P*
Statin	1.780	1.137-2.785	0.136	0.012
Ischemic heart disease	1.338	0.806-2.220	0.144	0.260
Beta-blocker	1.180	0.729-1.911	0.145	0.501
Diabetes mellitus (type I and II)	0.462	0.277-0.771	0.136	0.003
Chronic kidney disease	0.400	0.219-0.731	0.136	0.003
Diabetic nephropathy	0.272	0.093-0.795	0.136	0.017
Cerebrovascular disease	0.259	0.142-0.472	0.136	0.000
No comorbidity	0.352	0.177-0.701	0.136	0.003

CI=Confidence interval, BP=Blood pressure

prescribed medications were beta-blockers (54.2%) and ACEIs (48.5%). In cerebrovascular disease, beta-blockers and ACEIs were used with the same percentage (30.3%). However in renal disease, the most prescribed medications were beta-blockers (60.6%), diuretics (45.9%) and CCB (44.2%).

At discharge, the most prescribed medication for diabetic patients was ACEIs (71.4%). For IHD beta-blockers remained the most prescribed antihypertensive class (76.4%). Diuretics were the most prescribed in HF (85.7%). The highest use medication for patients with cerebrovascular disease was ACEIs (72.7%). In renal disease, beta-blockers remained the most used medication (68.8%).

Number of antihypertensive drug on admission and discharge

On admission, 26 of the patients were not on treatment and 24% were on monotherapy, 25% were on two drug combinations, 17% were on three drug combinations. On discharge only 1% were not on treatment, 26.3% on monotherapy, 35.8% were on two drug combinations and 28.3% on three drug combinations. The number of patients who were not on treatment decreased significantly to 1% upon discharge ($P < 0.001$). There was no significant difference in a number of patients who were on monotherapy between admission and discharge ($P = 0.453$). The increase was significant on those who were on two ($P = 0.001$) and three drug combinations ($P < 0.001$). There was no significant difference in the number of patients who took four and five drug combinations between admission and discharge ($P > 0.1$). The number of medications increased during the hospital stay, the majority of patients discharged with one or more medications (99%). The mean number of medication increased from 1.5 to 2.2. The number of medication increased in 30.2% of those who had controlled blood pressure (BP) and in 54.6% of those who had uncontrolled BP. The results also show that 26.3% of the patients admitted were not on treatment. The most used two drug combinations were beta-blockers and ACEI followed by beta-blockers and CCBs. The most prescribed three drug combination was diuretic, beta-blockers and ACEIs followed by beta-blockers, CCBs and ACE inhibitors. Furthermore, our results also show that only four patients were discharged without medication. There was no difference in the most used drug combination between admission and discharge. The most used two drug combinations were beta-blockers and ACEIs, followed by beta-blockers and CCBs. The most prescribed three drug combination was diuretic, beta-blockers and ACE inhibitors followed by beta-blockers, CCBs and ACE inhibitors.

DISCUSSION

The results showed a high prevalence of other co-morbidities especially diabetes and ischemic heart disease among hypertensive patients. This is consistent with other studies. In a study carried out in a hospital in the east coast of Peninsular Malaysia, there was a high prevalence of cardiovascular risk factors among inpatient with hypertension. Cerebrovascular disease was found in 33%, ischemic heart disease in 30% and diabetes in 18%.[25] The results of the present study showed low BP control on admission (24%). This was better than the result of a study in Italy that showed that only 13% of inpatients had their BP control on admission.[26] On discharge, BP control improved to 54% that was still far from optimal. A study in France reported that 67.1% had their BP control on discharge.[27] However, the Italian study showed that only 23.2 had controlled BP on discharge.[26] There was a significant reduction of the mean BP between admission and discharge. The mean reduction in systolic BP was 35 mmHg, and the mean reduction of diastolic BP was 14 mmHg. This was better than the results from the study performed in Italy,[26] which showed that the mean reduction in systolic BP was 23 mmHg and the mean reduction in diastolic was 11 mmHg. Female gender was associated with poor BP control in the present study which was different from Italian study that showed that male gender was a predictor of poor BP control.[26] In a community-based study in Malaysia; women were more likely to have poor BP control than men except in Indians.[9] The poor BP control among women in the current study may be due to characteristic of women in the study population. Women had older mean age compared to men (61.6 years vs. 57.2 years)

and also they are more diabetic than men (60.2% vs. 50%) which were also statistically significant. In this study patients who had no co morbidity were found to have poorer BP control compared to those with co morbidity. This is consistent with the result from a study in primary care practice in United States which found more than one co-morbidity was a predictor of good control of hypertension.[28] Another study in outpatients in primary care setting showed that the number of co-morbidities was positively associated with hypertension control.[29] This could be explained by increased number of medication in those with comorbidities. In the current study, on admission, patients with co-morbidities took 1.7 medications while those without comorbidity took 0.76 medications and at discharge the numbers increased to 2.25 and 1.85 respectively, all with a statistically significant difference.

Diabetic patients were found to have poor BP control on admission and on discharge compared with nondiabetic patients. This contrasted with results from Onder *et.al.* who reported no difference in BP control on discharge between diabetic and nondiabetic admitted to Italian hospitals (24.5% vs. 22.8%), however BP control on admission was not reported in diabetic patients.[26] Many studies showed that hypertension is difficult to be controlled in the diabetics. For example, a study performed by Banegas *et al*. indicated that hypertension was controlled in only 10.5% of diabetic patients.[30] In a study of hypertensive patients visiting 12 internal medicine clinics in United States, diabetic patients were found to be less likely to have their BP controlled than nondiabetic patients.[31] A study of correlates of BP control in primary care found that being diabetic reduce the odds of controlled hypertension by 64% (95% CI: 0.21-0.79).[29] The reason for poor BP control among diabetics patients in the current study could be due to the diabetes itself, old age of diabetic patients (60.3 vs. 58.6), predominance of women (56.1% vs. 43.9% P = 0.040) and Malay ethnicity (38.5% P = 0.00). Other studies reported diabetes as a reason for poor BP control. No study mention old age, women gender, and Malay as reasons for poor BP control in diabetics.

Stroke and diabetic nephropathy were found to be associated with poor BP control in this study. Majority of patients with stroke had uncontrolled BP on admission and at discharge. Compared with outpatients study in Nigeria, BP control on admission in this study was lower, but was better at discharge.[32] The relation between stroke and uncontrolled hypertension can be explained by either uncontrolled hypertension as a cause of stroke or as difficulty of controlling hypertension in patients with stroke. In a cross-sectional a study on hypertensive with a history of stroke and myocardial infraction in France, it was found that BP control was lower in stroke compared to myocardial infraction (24.56% vs. 34.16%).[33] In the current study BP control in stroke was lower than BP control in myocardial infraction. Also, hospitalized patients with stroke were on monotherapy more than hospitalized patients with myocardial infraction (43.16% vs. 31.44%). Other studies in outpatients also reported poor hypertension control among patients with a history of stroke.[34] In the current study, patients with stroke took less medication (1.02) compared with patients without stroke (1.63) which may explain their poor BP control.

Patients with diabetic nephropathy were found to have poor hypertension control in this study. In a study in an outpatient clinic in Nigeria, uncontrolled BP was found in 64.9% of those with diabetic nephropathy.[32] Both diabetes and renal disease are associated with poor hypertension control.

Blood pressure control was found to be associated with statin therapy on admission and discharge. This is consistent with the result of a study in outpatients compliant male Veteran, in which BP control was associated with long treatment with statin therapy (>1-year).[34] There are some studies showed that statin therapy is associated with the reduction of both systolic and diastolic BP. In a prospective population-based study of 1356 subjects in Brisighella, Italy, statin therapy was significantly associated with the reduction of systolic and diastolic BP and this was observed more in individual with greater reduction in low-density lipoprotein cholesterol.[35] In this study, diuretics were associated with BP control on admission and on discharge only beta-blockers were associated with BP control. Beta-blockers and ACEIs were found to be associated with good BP control in an outpatient clinic of Veterans Affairs medical center in United States.[34] The association of diuretic and beta-blocker with good BP control in the current study may be explained by high frequency of ischemic heart disease and diabetes among the study population of this study, which leads to increase usage of diuretics and beta-blockers.

CONCLUSION

This study address hypertension control and it predictors among patients admitted to medical

wards. About one-fourth of the patients admitted with controlled hypertension and this proportion increased to one-half on discharge. This shows a low rate of hypertension control even in hospitalized patients. Aggressive treatment is needed as the results showed that number of medication was positively associated with BP control and treatment was increased only in 54.6% of those who had uncontrolled hypertension. Women had low rate of BP control compared to men. Also, Malay race was associated with poor BP control. Having diabetes, stroke, renal disease, and retinopathy make patients more likely to have uncontrolled hypertension. In contrast having coronary artery disease was associated with better BP control. Being on beta-blockers, diuretic, statin and angiotensin inhibitors were more likely to achieve BP goals.

Limitations of this study

As an observational study, the current study has some limitations. The first limitation is that the role of lifestyle modification cannot be ascertained. This is because information on lifestyle modification cannot be extracted from the patient's reliability. Another limitation is that no direct interview of patients was done to ascertain patient-related factors contributing to poor control. Such factors include compliance to treatment and follow-up, family support, transportation and accessibility to health facilities. This is because the researcher is a foreigner and cannot communicate with local patients fluently.

This communication barrier may also affect the process of authoring a validated questionnaire for such purposes. Another potential limitation is that patients were included in the study consecutively as they were admitted to the hospital.

Recommendations

- Further prospective studies on hypertension control on inpatients are needed
- There is a need for a long term prospective study to compare BP control and the factors associated with it between inpatients and outpatients
- Hypertension in patients hospitalized with a stroke, renal disease and diabetes need to be studied. Prospective and retrospective studies with large sample sizes are needed to confirm poor BP control in these patients and to determine the reason of poor BP control
- Randomized controlled studies on the effect of antihypertensive on Malay, Chinese and Indian are needed to examine the effect of genetic variation in response to antihypertensive medications.

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