Physician triggers for changing pharmacological treatment in hypertensive patients

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Abstract

Hypertension is the number one reason to visit the family physician in Canada and is responsible for substantial health care expenses. Approximately one third of community-dwelling Canadians with hypertension have blood pressure (BP) levels exceeding recommended thresholds, and this is partly related to a physician's willingness to alter drug treatment in hypertensive patients. The primary objective of this quality improvement study was to compare the factors that differ between patients with controlled and uncontrolled BP in order to identify potential physician triggers for alteration of drug therapy in hypertensive patients or those with high BP. Patient files from the Kaye Edmonton Clinic were analyzed and relevant patient demographics, health history, current medications, and changes to BP were recorded. A chi-square analysis was then used to determine any significant differences between patients with controlled and uncontrolled BP. Only one significant difference was noted: patients with a controlled BP responded more positively to changes in drug therapy compared to patients with uncontrolled BP. Nonetheless, patients with a controlled BP were often younger and had a shorter duration of hypertension. These findings offer potential physician triggers that need to be investigated further. A future study involving a longer period and wider study population is needed in order to obtain more meaningful information regarding when to alter drug therapy.

Key words

Hypertension, HTN, blood pressure, guideline adherence, drug therapy, quality improvement

Introduction

High blood pressure (BP) is the leading risk factor for global disease burden[1] and is responsible for approximately 54% of stroke, 47% of ischemic heart disease, and 25% of other cardiovascular disease (CVD) worldwide[2]. For Canadians, hypertension is the number one reason for primary care physician visits[3], and approximately 2 in 5 adults can expect to be diagnosed with hypertension[4, 5]. Of these, approximately one third of community-dwelling Canadians with hypertension have BP levels exceeding recommended thresholds[6]. Similar results are seen in the United States and the European Union[7, 8].

It is estimated that if optimal BP levels are achieved in hypertensive individuals, more than one third of coronary heart disease (CHD) events could be prevented[9]. Patients with a more intensive treatment regimen are known to have better controlled BP[8, 10]. Yet, for those with poor BP control, changes in drug therapy are seen in as little as 38% of cases[11]. Therefore, poorly controlled BP is directly related to a physician's willingness to initiate or change a patient's treatment regimen[11, 12]. Patient and/or physician barriers to BP guideline-adherence offer potential explanations as to why physicians are not modifying patient medication plans when needed.

There have been a number of studies that have managed to determine physician specific factors influencing the attainment of BP targets. To generalize, these factors include physician knowledge, attitudes, or behavior[13, 14]. A lack of self-efficacy regarding guidelines[13, 15]; awareness, familiarity, and ability to apply guidelines[16-19]; and problems with the guidelines themselves[13, 20-23] are just some of the barriers to guideline adherence. Uncertainty regarding a patient's true baseline BP[24, 25], perceived risk of pharmacological treatment[11, 14, 26, 27], lack of outcome expectancy[28, 29], difficulty communicating to and

educating patients[14], and external factors such as resources and facilities[13, 21, 30, 31] are just a few more pertinent factors.

Patient factors also exist, which can influence a physician's decision to alter therapy. Although factors impeding adequate BP control include health beliefs, clinical factors, demographic characteristics, and socioeconomic factors, one of the most commonly cited reasons for the failure to achieve BP targets is patient non-adherence[12, 32-34]. Studies show that only about two thirds of individuals take their entire prescribed dosage of antihypertensives, and this adherence has not improved significantly over the years [34, 35]. Patient nonadherence has been associated with inconvenient or costly drug regimens[12, 34, 36-44], duration of treatment[40], cost/benefit to receiving treatment[45], social factors such as stigma and depression[43, 46], patient awareness of treatment[8, 12, 47], and inadequate education or understanding provided by the physician[14, 43-45, 48].

An earlier study by Berlowitz et al. (1998) actually managed to characterize the factors associated with an increase in antihypertensive treatment. Alterations to drug therapy were thought to be influenced by a scheduled visit, prior changes in therapy, an increase in systolic and diastolic BP during the time of visit but not previous visits, and the presence of CHD. Patient factors such as one's age, cardiovascular risk factors other than high BP, and complications resulting from hypertension did not serve as physician triggers to changing the pharmacological treatment of hypertension in patients. Only those with

d a BP of <165/<90 mmHg were associated with an increase in the likelihood of therapy alteration. However, despite the findings, this study was limited by its study population, which included 800 male veterans with hypertension most of whom were elderly, white, and had many coexisting conditions. One would think that knowledge of

these triggers would help physicians identify when intensification of treatment is needed. However, changes in drug therapy are still only occurring in 38% of cases[11], which suggests that Berlowitz et al.'s study population may not be generalizable as the authors suggested. Thus, further study of the factors behind a physician's decision to alter pharmacotherapy is of interest.

In order to improve the management of hypertension across Canada and other parts of the world, a more representative study population is required. This will allow us to educate physicians on when intensifying therapy may be appropriate, which will help prevent future deviation from recommended guidelines. Better BP control will subsequently decrease cardiovascular disease events and associated costs.

The hypothesis of the current proposal is that many physicians are equally stringent in the treatment of hypertensive patients with many risk factors in comparison to those with only a few risk factors. Aims were to identify the potential triggers or behaviors that influence a physician's prescribing patterns for those with high BP as well as to complete a risk factor analysis of those with hypertension. The *primary outcome* of this study was the identification of physician triggers for changing or maintaining pharmacological treatment in hypertensive patients. The s*econdary outcome* was determining whether or not BP was equally controlled in patients with greater health risks.

Methods

Identification of study subjects

Physicians (nephrologists) from the renal department of the Kaye Edmonton Clinic – an urban centre located next to the University of Alberta Hospital – were asked to participate in the quality improvement study. A patient list for each participating physician was generated. Patient's who had not followed up with their physician since 2012 were immediately excluded. Next, patients whose files were in rural clinics, in the Renal Insufficiency Clinic, or otherwise inaccessible were also excluded. Using a random letter-number generator, patient files were then selected from the list for an initial screening.

Patients were required to meet the initial screening criteria in order to be further analyzed. Patients had to be diagnosed with hypertension as assessed by the use of one or more antihypertensive drugs or patients had to exhibit BP levels exceeding acceptable limits at one or more of their five most recent visits. They also had to be between 20-80 years of age, had to have a minimum of five BP measurements recorded since January of 2011, and had to have not undergone a transplant. All necessary patient information also needed to be legible otherwise the patient was excluded. Patients that met these criteria were then studied, and a discrete identification was made on each patient file so that they would not be repeated.

Blind testing was not practical or necessary in the study. Only existing data/observations were compiled, and patients were chosen at random. The patients were unaware of the study, and no personal information was recorded.

Recorded data

The following patient information was extracted from each file:

- Age (at the time the filed was viewed) and gender of the patient
- Their five most recent BP measurements since January 1st, 2011
- Any physician notes regarding the patient's BP or hypertension
- Current antihypertensive medications
- Changes to any of these medications in the patient's last five visits (increase or decrease)
- Documented reasons for changing the medications
- Duration of hypertension (years)
- Number of visits to care giver since January, 1st 2011 (#)
- Whether the patient had been a no-show or not (yes or no)
- Last low density lipoprotein-cholesterol (LDLC) [mmol/L], high density lipoprotein-cholesterol (HDLC) [mmol/L], blood glucose [mmol/L] or hemoglobin A1C (HBA1C) [%], estimated glomerular filtration rate (eGFR) [ml/min/1.73m^2], weight [kg], and height [m] measurements
- Family history of hypertension (yes or no)
- Current use of tobacco or alcohol (yes or no)
- Sleep apnea (yes or no)
- Diabetes mellitus
- Target organ damage (TOD)
    - Diabetic retinopathy, diabetic nephropathy, diabetic hepatopathy, diabetic vasculopathy, membranous nephropathy (yes or no)
    - Left ventricular hypertrophy, angina pectorsis, past myocardial infarction, coronary artery bypass (yes or no)
    - Proteinuria, nephrectomy (yes or no)
    - Claudication, femor stenosis, amputation, diabetic vascular disease (yes or no)
    - Transient ischemic attack, cerebrovascular accident, carotid artery stenosis (yes or no)
    - Other relevant medical conditions (glomerulonephritis and coronary artery disease)

Using this information, a risk factor analysis for each patient selected was then completed in order to determine whether one's health risk influenced stringency in his or her treatment of high blood pressure.

Data analysis

BP was considered to be under control if values fell below the acceptable treatment targets found in to Table 1. The following treatment targets are recommendations set forth by CHEP 2013[49].

Table 1. CHEP recommended treatment targets for those already being treated using non-pharmacological and/or pharmacological means

Population	**SBP [mmHg]**	**DBP [mmHg]**
Diabetes	<130	<80
All others (including CKD)	<140	<90

SBP = systolic blood pressure, DBP = diastolic blood pressure, CKD = chronic kidney disease.

A patient's BP was separately classified as being either controlled or uncontrolled on the basis of two indicators: whether their most recent BP measurement met the treatment targets (group 1) or whether their average BP across the five most recent measurements met the treatment targets (group 2). Physician triggers for changing pharmacological treatment in hypertensive patients were identified by noting discrepancies in the possible factors influencing the intensity of a patient's therapy both amongst and between controlled and uncontrolled BP groups.

Triggers were defined to be a set of specific factors (e.g. medical or demographic) existing independently or in combination with each other that influence a physician's decision to alter drug therapy. Examples of triggers include but are not limited to elevated

BP levels, frequency of visits to care provider, consistency of BP readings, patient demographics, existing medication, patient non-adherence, and existing health risks.

A risk factor analysis for each patient was also completed in order to determine whether or not BP was equally controlled in patients with many health risks compared to those with less health risks. Risk factors included having an age over 60 years; having a family history of hypertension; having TOD; having diabetes mellitus; having abnormal blood glucose or HBA1C levels, abnormal LDLC and/or HDLC levels, or an abnormal eGFR; having sleep apnea; being overweight or obese; or using tobacco and/or alcohol. Risk factors and TOD were recorded as either a presence (value = 1) or absence (value = 0). These values were tallied for each individual in order to determine their total risk. A value of 1 was given for each abnormal cholesterol measurement (LDLC and HDLC) as well as each example of TOD. For all number measurements, the average and standard deviation of each category was calculated if possible, and a chi-square (X^2) analysis was performed when appropriate.

Results

A sample of 31 patients from the Kaye Edmonton Clinic was evaluated, most of whom were older males with many risk factors (Table 2). Many of the patients had a controlled BP across both indicators of control, and many were also taking 3 or more antihypertensive medications. Poor diet was a commonly cited as a possible cause for high BP. Over the five BP measurements that were recorded, there were changes in medication for 28 of the patients studied. For the remaining 3 patients, 2 had adequate BP control for both indicators, and the remaining patient was not diagnosed with hypertension but rather

had high BP for one or more visits. In addition, there was only one occurrence where a patient had not kept his appointment; otherwise, all patients made their scheduled visits.

Table 2. General characteristics of the study population

Characteristics	Value
Sample size (#)	31
Age at time of study (avg. yrs)	60 ± 13.6
Males (#)	23
Females (#)	8
No. of those with controlled BP	19
No. of those with uncontrolled BP	12
Duration of HTN (avg. yrs)	9.7 ± 10.2
No. of antihypertensive Rx (#/%)	
0	1/3.2
1	7/22.6
2	6/19.4
3	10/32.3
≥ 4	7/22.6
No. of those with selected risk factors (#)	
Hypertension	30
TOD	19
Other	18

The number of those with controlled and uncontrolled BP was the same across Group 1 and Group 2. avg. = average, yrs = years no. = number, HTN = hypertension, Rx = medications, TOD = target organ damage.

Patient characteristics were compared between group 1 classifications and can been seen in Table 3. Most of the individuals with a controlled BP were younger in age, had a shorter duration of hypertension, visited their physician less frequently, were taking less antihypertensive medication, responded better to changes in medication ($p<0.05$), and had a controlled average BP across their five most recent visits ($p<0.05$). One can also note a significant difference between the number of males and females within the uncontrolled BP group. Differences between the types of antihypertensive medications being taken between the two groups were unremarkable.

Table 3. Summary table of individuals with a controlled versus uncontrolled blood pressure for their *most recent measurement* (group 1)

Characteristics	**Controlled BP**	**Uncontrolled BP**	**X^2**
Subsample sizes (#)	19	12	1.581 (p>0.05)
Age at time of study (avg. yrs)	58.1 ± 14.9	63.6 ± 10.9	0.249 (p>0.05)
Males (#)	13[1]	10[2]	0.391 (p>0.05)
Females (#)	6[1]	2[2]	2.000 (p>0.05)
Duration of HTN (avg. yrs)	8.1 ± 5.9	11.8 ± 13.9	0.688 (p>0.05)
No. of visits since January 2011 (avg. #)	6.7 ± 3.0	7.0 ± 3.3	0.007 (p>0.05)
No. of antihypertensive Rx (avg. #)	2.4 ± 1.6	2.9 ± 1.2	0.047 (p>0.05)
Those with better BP control following Rx change (%)	83.3	10.0	57.587 **(p<0.05)**
Those with a controlled avg. BP across 5 measurements (%)	84.2	25.0	32.094 **(p<0.05)**

[1] the X^2 between these values – controlled males and females – is 2.579 (p-value>0.05)
[2] the X^2 between these values – uncontrolled males and females – is 5.333 **(p-value< 0.05)**
All X^2 values were calculated with a degrees of freedom of 1. $\alpha = 0.05$ for the p-value.

For group 1, a comparative risk factor analysis between controlled and uncontrolled BP groups was performed (Table 4). Overall, the controlled BP group had more risk factors within group 1 but had a lower average number of risk factors in comparison to the uncontrolled BP group. The total number of risk factors for controlled and uncontrolled BP groups was determined by summing each risk factor tally for every individual in the group. Note that the number of individuals having a specified risk factor does not account for how many risk factors they had in that particular category.

Table 4. Risk factor analysis of those with a controlled versus uncontrolled blood pressure for their *most recent measurement* (group 1)

Risk factors	**Controlled BP (# of individuals)**	**Uncontrolled BP (# of individuals)**	**X^2**
>60 years of age	9	9	/
Family history of HTN	4	4	/
TOD	10	9	0.053 (p>0.05)
Diabetes mellitus	7	7	/
Abnormal blood glucose or HBA1C (s = 25)	4	3	0.143 (p>0.05)
Abnormal LDLC levels (s = 24)	9	4	1.923 (p>0.05)
Abnormal HDLC levels (s = 24)	12	5	2.882 (p>0.05)
Abnormal eGFR (s = 29)	7	2	2.778 (p>0.05)
Sleep apnea	2	1	0.333 (p>0.05)
Overweight	8	3	2.273 (p>0.05)
Obese	5	9	1.143 (p>0.05)
Tobacco use	3	2	0.200 (p>0.05)
Alcohol use	8	3	2.273 (p>0.05)
Sample Size	19	12	1.581 (p>0.05)
Total risk factors in group	105	81	3.097 (p>0.05)
Avg. no. of risk factors per person	5.5 ± 3.4	6.8 ± 3.8	0.137 (p>0.05)

Diabetes mellitus included those with Type I and Type II diabetes. Abnormal blood glucose was taken to be <4.0 or >5.9 mmol/L for non-diabetics and <4.0 or >7.0 mmol/L for diabetics, whereas abnormal HBA1C was >5.9% for non-diabetics and >6.5% for diabetics. Abnormal LDLC levels were >2 mmol/L, HDLC levels were <1.6 mmol/L, and eGFR was <60 ml/min/1.73m^2. Individuals were considered overweight if they had a BMI >25 and obese if >30. Tobacco and/or alcohol use was based on current rather than past use. All X^2 values were calculated with a degrees of freedom of 1. $\alpha = 0.05$ for the p-value, s = sample size and it indicates the fact that not all 31 patients had the desired measurements.

Patient characteristics were also compared between group 2 classifications (Table 3). The same observations were made in group 1 with respect to average age, duration of hypertension, frequency of visits, number and type of antihypertensive medications, response to changes in drug therapy, BP in relation to the other control indicator, and gender discrepancies.

Table 5. Summary table of individuals with a controlled versus uncontrolled average blood pressure *over all five measurements* (group 2)

Characteristics	**Controlled BP**	**Uncontrolled BP**	**X^2**
Subsample sizes (#)	19	12	1.581 (p>0.05)
Age at time of study (avg. yrs)	59.7 ± 15.8	60.9 ± 9.7	0.012 (p>0.05)
Males (#)	13[1]	10[2]	0.391 (p>0.05)
Females (#)	6[1]	2[2]	2.000 (p>0.05)
Duration of HTN (avg. yrs)	8.75 ± 6.2	11.2 ± 14.4	0.301 (p>0.05)
No. of visits since January 2011 (avg. #)	6.1 ± 1.3	8.0 ± 4.5	0.256 (p>0.05)
No. of antihypertensive Rx (avg. #)	2.3 ± 1.2	3.1 ± 1.8	0.119 (p>0.05)
Those with better BP control following Rx change (%)	83.3	10.0	57.587 **(p<0.05)**
Those with a controlled BP for their most recent measurement (%)	84.2	25.0	32.094 **(p<0.05)**

[1] the X^2 between these values – controlled males and females – is 2.579 (p-value>0.05)
[2] the X^2 between these values – uncontrolled males and females – is 5.333 **(p-value< 0.05)**
All X^2 values were calculated with a degrees of freedom of 1. $\alpha = 0.05$ for the p-value.

The comparative risk factor analysis for group 2 is found in Table 6. Similar results to that seen in Table 4 can be observed.

Table 6. Risk factor analysis of those with a controlled versus uncontrolled average blood pressure *over all five measurements* (group 2)

Risk factors	**Controlled BP (# of individuals)**	**Uncontrolled BP (# of individuals)**	**X^2**
>60 years of age	10	8	0.222 (p>0.05)
Family history of HTN	4	4	/
TOD	9	10	0.053 (p>0.05)
Diabetes mellitus	5	9	1.143 (p>0.05)
Abnormal Blood glucose or HBA1C (s = 25)	4	4	/
Abnormal LDLC levels (s = 24)	8	5	0.692 (p>0.05)
Abnormal HDLC levels (s = 24)	10	8	0.222 (p>0.05)
Abnormal eGFR (s = 29)	6	3	1.000 (p>0.05)
Sleep apnea	1	2	0.333 (p>0.05)
Overweight	8	3	2.273 (p>0.05)
Obese	5	9	1.143 (p>0.05)
Tobacco use	3	2	0.200 (p>0.05)
Alcohol use	7	4	0.818 (p>0.05)
Sample Size	19	12	1.581 (p>0.05)
Total risk factors in group	88	98	0.538 (p>0.05)
Avg. number of risk factors per person	4.6 ± 1.9	8.2 ± 4.5	1.013 (p>0.05)

See figure legend for Table 4.

In addition to the observations extracted from the data, there were also documented reasons for changing BP medication. These include medication not being effective, individual being too over controlled, exacerbation of a side effect, and increasing prevalence of contraindications. Financial constraint was cited as a reason for not taking medication.

Discussion

Improving disease management through quality improvement strategies has shown the most potential and effectiveness in terms of overcoming the difficulties associated with achieving better BP control[12, 50]. Yet, despite evident improvements to the recognition and treatment of hypertension in Canada[3, 6, 51], many physicians are not being aggressive

enough in their treatment of hypertension[8, 10] even with the knowledge that better BP control comes with a more intensive antihypertensive regimen. Noticeable improvements to the management of hypertension will likely come with greater knowledge of physician prescribing patterns and habits. This study aimed to identify the potential triggers that would influence a physician's decision to alter drug therapy in hypertensive patients in order to further decrease the prevalence of hypertension in the adult population.

Differences between individuals with controlled and uncontrolled BP were identified, and knowledge of these differences could serve to influence a physician's decision on treatment. Controlled and uncontrolled BP groups appeared to differ on the average patient's age, duration of hypertension, and one's response to changes in medication; although, the former two were insignificant differences. Neither number nor type of risk factor observed appeared to have influenced patient BP control. However, between groups 1 and 2, individuals with uncontrolled BP still had a higher average number of risk factors and antihypertensive medications. Beyond these explainable differences, there was no evidence to suggest that physicians were not equally stringent in treating those with higher health risks even though hypertension did not appear to be better controlled in these patients.

These results both support and refute other findings such as those by Berlowitz et al. in 1998. They found that a patient's age and the existence of relevant risk factors did not serve as physician triggers for modifying drug therapy. Both of these findings were observed considering the insignificant differences between age and existing risk factors between the two groups. In contrast, Berlowitz et al. also found that the nature of one's visit, previous changes to therapy, high BP pressure during the time of visit, and the

presence of CHD served as physician triggers. None of these factors were observed in this experiment. One must note that their study population consisted of 800 male veterans who were primarily white, older in age, and had many coexisting risk factors[10]. Therefore, the triggers identified by Berlowitz et al. are likely not generalizable to wider populations.

Similarly, however, this study population also consisted of mainly males who were older in age with many other risk factors. This suggests that the sample size was likely too small, because gender and age appeared to be skewed. Nevertheless, the observed study population could indicate that most individuals do not see a nephrologist until they are of older age and have many other risk factors present. Also, having studied a greater number of males than females despite the random selection process suggests that females may either be less susceptible to hypertension or may be less likely to seek help through a nephrologist. The latter possibility is more likely since the crude prevalence of hypertension is higher among women than men[52]. Even so, gender differences do not affect the timing of referral to a nephrologist; therefore, one would actually expect a nephrologist to have more female patients because of their increased rates of hypertension. One must also note that individuals under 30 years of age have a significantly increased likelihood of having a late referral compared to those over 30, which can help to explain the skew in age that was observed[53].

Age may also account for differences in BP control. Younger patients were noted to have better control of BP, and this may be explained by a number of reasons. Younger men and women likely have a lower perceived risk of treatment due to the presence of less coexisting conditions and medications. Nearly all medication is associated with possible adverse side effects and contraindications, which inherently influence a physician's

decision to initiate or change existing drug therapy[14, 26]. This perception of risk also helps to explain why studies have demonstrated that in older patients, physicians tend to accept systolic BPs exceeding threshold values before changing or initiating treatment[11, 27]. As patients become older, many of the risks associated with a medication begin to outweigh the benefits; thus, blood pressure may be less controlled as a consequence.

A number of other factors were also compared between controlled and uncontrolled BP groups, and the average duration of hypertension is another difference worth noting although statistically insignificant. Patient non-adherence, which is related to the duration of treatment, is a probable explanation for a less controlled BP observed in those with a longer duration of hypertension[54, 55]. Individuals may simply get tired of taking medications or not fully understand the chronic nature of hypertension. In addition, those with a longer duration of hypertension also tended to be on more antihypertensive medications. Together, this may suggest a growing tolerance to the medications prescribed, which is known to occur[56-58] and is supported by the observation that individuals with an uncontrolled BP tended to respond less positively to changes in the medication regimen. Or, some patients could have even developed resistant hypertension[59]. Nonetheless, one's specific physiology may be responsible for medications having less of an effect.

Despite individuals in the controlled BP group having a lower average number of antihypertensive medications, when compared to those with uncontrolled BP this represents an insignificant difference. Although medication doses were not recorded, it may be possible that individuals with a better-controlled BP are taking less antihypertensives but are receiving larger doses in comparison to those with a less controlled BP. This would make sense since the intensity of one's therapy is not necessarily

measured by the number of medications one has, and patients with a more intense antihypertensive treatment regimen have been shown to have better controlled BP [8, 10].

Regardless, the absence of notable differences in the types of antihypertensive medications prescribed between the controlled and uncontrolled BP groups and the non-significant difference in the number of medications prescribed between the two groups suggests that either physicians are not intensifying therapy when they should be or that patient non-compliance may be present. Since monotherapy with antihypertensives is less common than combination therapy, patients are subjected to a greater number of medications. This often results in a more complex drug regime, and together with an increase in the amount of drugs one is taking, patients may become noncompliant[12, 36-41]. Studies have shown that patients who believed they were on 'too many' medications had the lowest compliance[34, 42, 43], and those who reported being on 'too little' of medication had the highest compliance[34]. This, is in addition to another study showing that only about two thirds of individuals take their entire prescribed dosage of antihypertensives[35] provides support for the possible presence of patient non-compliance.

A positive observation worth nothing is the presence of a greater proportion of individuals with a controlled BP in comparison to those with an uncontrolled BP. This is a promising finding even though much work is needed in order to adequately control the BP of those who are currently uncontrolled. In addition, where previous studies reported changes in drug therapy only occurring in 38% of cases[11, 12], change happened for 90% of all individuals across their five most recent measurements. Furthermore, depending on what blood pressure control indicator one uses, changes in drug therapy happened in

100% of those with uncontrolled hypertension. This is a good indication that physician's are now more aware of when to alter drug therapy.

The results obtained in this study appear to represent accurate differences between controlled and uncontrolled BP populations as evident in the observation that most individuals with a controlled BP for their most recent measurement also had a controlled BP average across their five most recent visits and vice versa. This suggests that categorizing an individual on the basis of whether their BP was controlled at their most recent visit or across their five most recent visits is an accurate indicator of whether one's BP is currently controlled or not. Furthermore, this helps to explain the similar results seen between groups 1 and 2.

These results indicate that patients with a controlled BP tended to respond more positively to changes in medication, which represented a significant difference between controlled and uncontrolled BP groups. Nonetheless, those with a controlled BP tended to be younger in age and have a shorter duration of hypertension. The risk factor analysis revealed an insignificant difference between the total and average number of risk factors between patients in the controlled and uncontrolled BP groups, which indicated equal stringency in the treatment of hypertension between those with varying health risks.

This study was limited in its duration and the amount of patients that were observed. Also, participating physicians were all chosen from a localized urban area, which may limit the generalizability of results. Furthermore, patient files were analyzed based on their ease of accessibility, and the patient lists generated were not always up to date. A future follow up study involving a longer period and wider study population can address these limitations. Recording a patient's total number of medications and antihypertensive

dosages would also be valuable modifications to the current study design. Based on these preliminary results, there appear to be discriminating factors influencing BP control in patients, but further study is needed in order to provide physicians with more meaningful information regarding when to alter drug therapy.

Appendix

Table 7. Additional general characteristics of the study population

Characteristics	Value
No. of those with selected risk factors (#)	
Hypertension	30
Diabetes mellitus	14
Hyperglycemia	6
Dyslipidemia	18
TOD	22
Family history of HTN	8
Overweight	11
Obese	14
Sleep Apnea	3
Tobacco use	5
Alcohol use	11

Table 8. Additional summary table of individuals with a controlled versus uncontrolled blood pressure for their *most recent measurement* (group 1)

Characteristics	Controlled BP	Uncontrolled BP
No. of antihypertensive medications (avg. #)	2.4 ± 1.6	2.9 ± 1.2
ACE, ARB, or renin inhibitors	1.1 ± 0.2	1.0
Beta blockers	1.0	1.0
Calcium antagonists	1.1 ± 0.3	1.0
Diuretics	1.1 ± 0.4	1.0
Central acting	1.0	1.0
Non-specific vasodilators	0.0	1.0
Aldosterone inhibitors	1.0	1.0

Table 9. Additional summary table of individuals with a controlled versus uncontrolled average blood pressure *over all five measurements* (group 2)

Characteristics	**Controlled BP**	**Uncontrolled BP**
No. of antihypertensive medications (avg. #)	2.3 ± 1.2	3.1 ± 1.8
ACE, ARB, or renin inhibitors	1.1 ± 0.2	1.0
Beta blockers	1.0	1.0
Calcium antagonists	1.0	1.1 ± 0.4
Diuretics	1.0	1.1 ± 0.4
Central acting	1.0	1.0
Non-specific vasodilators	0.0	1.0
Aldosterone inhibitors	1.0	1.0

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