The Impact of Attire and Occupation on the Accuracy of Blood Pressure Measurements

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ABSTRACT:
White coat hypertension describes individuals with elevated blood pressure (BP) in medical facilities, such as clinics, and hospitals, but whose BP is normal when they are going about their daily activities. The purpose of this study was to assess whether certain types of healthcare providers are more accurately able to determine BP in comparison to the twenty four hour ambulatory blood pressure monitoring (ABPM), as well as to assess the effect of a healthcare provider’s attire on BP reading. The results show that BP readings were significantly higher when any of the healthcare providers wore a white lab coat. This suggests that attire of the healthcare provider has an impact on the BP readings. Cardiologists were most prone to causing white coat hypertension compared to nurses or cardiovascular technicians. It is therefore advised that alternate healthcare providers check BP to minimize the risk of erroneous BP readings and reduce the risk of white coat hypertension.

BACKGROUND:
White coat hypertension describes individuals with elevated blood pressure (BP) in medical facilities, such as clinics, and hospitals, but whose BP is normal when they are going about their daily activities [1]. Twenty four hour ambulatory blood pressure monitoring (ABPM) using an automated machine that records BP every 30 minutes while awake and every 60 minutes while asleep has been determined to be the most accurate method for BP recording. It is also the most accurate method to distinguish white coat hypertension from “true” hypertension, BP elevations that occur regardless of the external environment [2]. Prior studies show that white coat hypertension occurs in more than 20 % of the hypertensive population [2, 3]. In such patients, the BP elevation response in the physician’s office may lead to misclassification of patients as hypertensives, when they are not. Studies show that individuals with white coat hypertension have a significantly lower number of cardiovascular events than true hypertensives, but a higher number of events than normotensive patients without white coat hypertension [4, 5]. Thus, it is important to distinguish the difference between these three groups: hypertensives, white coat hypertensives, and true normotensives. It remains to be determined if some types of healthcare professionals measure BP more accurately than others; whether the physical appearance and attire of these healthcare providers make a difference, and if certain types of healthcare providers cause white coat hypertension more commonly than others.

PURPOSE:
The purpose of this study was to assess whether certain types of healthcare providers are more accurately able to determine BP in comparison to the “gold standard”, twenty four hour ABPM. This study will also assess the effect of a healthcare provider’s attire on BP reading.

HYPOTHESIS:
The occupation and stature of the healthcare professional as well as the attire of the individual measuring BP will impact the accuracy of BP readings. Specifically, cardiologists are hypothesized to cause the most white coat hypertension as they may provoke more anxiety and stress in patients than any of the other health care providers. If the healthcare professional wears a white lab coat, the BP reading will be higher than if they are wearing more casual clothing. It is hypothesized that the occupation of the professionals and their attire might intimidate the individual.

VARIABLES:
The dependent variable was the systolic BP of the participants. The Independent Variables were the Dependent health care professional measuring BP, and whether the health care professional is wearing a white coat, or normal attire. The environment, time of day, method, and device used to measure BP was all controlled.
METHODS:

Ethics:
A test protocol, & written informed consent form were reviewed by Dr. S. Sykes, University of Waterloo Human Research Ethics Board. We obtained written informed consent from all participants before any procedures were carried out. Ample time and opportunity was given for participants to ask questions.

Setting:
Recruitment and study procedures were carried out in the city of Cambridge (pop. 150,000), Ontario.

Population and Subject Selection:
All 50 participants were adult volunteers from a Canadian cardiology community practice (Cambridge Cardiac Care Centre). We included 50 consecutive adults, both with and without known hypertension. All participants were above 18 years of age, competent to provide informed consent, and were able to avoid caffeine and nicotine for the required 24 hour period. Children, mentally handicapped individuals, incarcerated individuals, those unable to provide informed consent, those unable to read and write in English, and those unable to adhere to the study protocol were excluded.

94 individuals were screened to participate in this study. 32 failed the inclusion criteria, due to language barriers, 10 declined to participate and 2 could not abstain from cigarettes prior to the study procedure.

Study Procedures:
Demographic information, including age, gender, medical diagnosis, and medication list was collected, with permission, from their medical chart. Participants’ BP were assessed by 3 different health care providers, a nurse, a cardiovascular technician and a cardiologist. The participants were informed in advance of the occupation of each of the different health care providers. All health care providers were asked to adhere to the Pan-American Journal of Health method of blood pressure measurement to assess blood pressure to eliminate sources of error. The health care providers measured the blood pressure of participants twice, once while wearing a standard white lab coat, and once while not wearing it. The sequence of healthcare providers measuring BP and whether they wore a white lab coats varied to reduce regression to the mean error and to eliminate bias. There was a 10 minute delay between each of the blood pressure assessments. All health care providers used an Omron manual blood pressure cuff (model # 760 HEM 7220-Z) to assess blood pressure. All participants had their blood pressures assessed by health care providers between 8:00 am-10:00 am.

Subsequently, a Spacelabs Ambulatory Blood Pressure Monitor (model # 90207-30) was applied to each participant. Each patient’s blood BP was recorded over a 24 hour period; one measurement was taken every ½ hour from 8 AM-10 PM, and every hour from 10PM to 8 AM. The mathematical mean of the BP readings in the daytime were compared to the readings obtained by the various healthcare providers. 

The Pan-American Journal of Health method of blood pressure Measurement:

1. Participant sits at a table quietly with both feet flat on the floor and with the back supported. The bladder should be empty. The room should be comfortable and noise minimized. No tobacco products, alcohol, or caffeine should have been consumed within the previous 30 minutes. If this is not possible, it should be noted in the data.

2. The right arm, which should be bare, is placed on the table (at heart level) slightly flexed, with the palm upward. The screener should be in position to see the manometer at eye level.

3. Determine arm circumference and select and wrap appropriate cuff size. The lower edge of the cuff must be 2.5 cm above the elbow joint.

4. Wait 5 minutes.

5. Palpate radial pulse and inflate to 30 mm hg above the level where radial pulse disappears (peak inflation level). Deflate cuff.

6. Wait 30 seconds before re-inflating.

7. Inflate to peak inflation level.

8. Deflate at 2 mm hg per second.

9. Record the systolic blood pressure.
10. Record diastolic BP, Korotkoff phase 5 (the end of the last sound heard).

11. Finish deflation, then raise participant’s arm above heart level for 15 seconds. Rest for one minute and then perform the measurement procedures two more times. Use the mean of the last two measurements.

**Data collection:**

Baseline demographics: age, gender, education levels, disease states, presence or absence of the diagnosis of hypertension, duration of hypertension, medications, height, weight, and abdominal girth, BP readings by each healthcare provider with and without wearing a white lab coat, and 24 hour BP readings using Spacelabs ABPM was collected.

**Statistical analysis:**

Statistical analysis was performed using GraphPad Instat 3.10. Paired, two-tailed Students t-tests were used for comparisons of two variables, such as the difference between the measurements of the cardiologist with a white coat vs. the measurements of the cardiologist without a white coat. ANOVA with Bonferroni correction was used for all comparisons with three or more variables with multiple comparisons, such as the subgroup analysis performed for specific pre-specified subgroups. These subgroups included young adults, middle age and elderly, men vs. women, those with less than high school education vs. those with post-secondary education, those with elevated waist circumference (>120 cm), and those with and without known hypertension, as well as those who were recently diagnosed with hypertension(<1 year). A p-value of 0.01 or less was considered statistically significant.

**RESULTS:**

**ANALYSIS:**

Participants were informed in advance of each health care provider’s occupation; however visual differences, such as gender, size and age may have impacted the results.

This study was conducted in a random group of individuals with varying BPs. Some were normotensive, some were mildly hypertensive and some were severely hypertensive.

**Figure 1.**

Average BP Measurement of Cardiologist with and without White Coat vs Ambulatory Blood Pressure Monitor. The BP measurements of the cardiologist with a white coat were on average 10 mm Hg greater than the measurements of the cardiologist without a white coat (p<0.0001). The average BP measurements of the cardiologist with and without a white coat were 23 mm Hg, and 13 mm Hg greater than the measurements of the Ambulatory Blood Pressure Monitor respectively (p<0.0001).

**Figure 2.**

Average BP Measurements of Cardiologist with and without White Coat vs Ambulatory Blood Pressure Monitor. The BP measurements of the cardiovascular technician with a white coat were on average 4mm Hg greater than the measurements of the cardiologist without a white coat (p<0.02). The average BP measurements of the cardiologist with and without a white coat were 23 mm Hg, and 13 mm Hg greater than the measurements of the Ambulatory Blood Pressure Monitor respectively (p>0.05).
Figure 3.
Average BP Measurements of Cardiologist with and without White Coat vs Ambulatory Blood Pressure Monitor. The BP measurements of the cardiologist with a white coat were on average 8 mm Hg greater than the measurements of the cardiologist without a white coat (p<0.0001). The average BP measurements of the cardiologist with and without a white coat were 13 mm Hg, and 5 mm Hg greater than the measurements of the Ambulatory Blood Pressure Monitor respectively (p<0.0001).

Figure 4.
Average White Coat Response (BP Measurements with White Coat vs without White Coat). The cardiovascular technician had the lowest white coat response with an average difference of 4.6 mm Hg, followed by the nurse, with an average difference of 8.4 mm Hg, followed by the cardiologist, with an average difference of 9.8 mm Hg.

Figure 5.
Subgroup Analysis of BP Measurements from Cardiovascular Technicians, Cardiologists and Nurses with a White Coat vs ABPM. In every subgroup, the cardiologist had the least accurate blood pressure measurement. The nurse had the second least accurate reading in every subgroup except “College Education,” and the cardiovascular technician had the most accurate result in all but one subgroup.

Figure 6.
Percentage of Accurate Readings of Cardiovascular Technician, Nurses and Cardiologist with and without a White Coat. The Cardiovascular technician had the greatest percentage of accurate readings (within 5% of ABPM), followed by the nurse, followed by the cardiologist. There was a significant difference between the accuracy of the measurements of the nurses and the cardiologist with vs. without a white coat.
hypertensive. This resulted in a great deal of variability and large standard deviations for the average or mathematical means of BP readings as taken by the ABPM device as well as the various health care providers.

Systolic BP was chosen as the measurement to reflect white coat hypertension since previous studies have suggested that this varies more than diastolic BP and may be affected more by white coat hypertension.1 According to these results, systolic BP readings vary by the type of health care professional as well as whether their healthcare provider wore a white lab coat or not. (Figure 1-6) This was found in all sub-groups analyzed. This study demonstrates that certain types of healthcare providers (specifically cardiologists) are more prone to causing the phenomenon of white coat hypertension, and had the least accurate readings. In all subgroups, the systolic BP measured by the cardiologist was consistently higher than the result of the ABPM, the nurse, and the cardiovascular technician. BP measured by the nurse was consistently higher than values obtained by the ABPM, and the CVT, but did not vary as far as the values obtained by the cardiologist. (Figure 1-6) There was no statistically significant difference between the results of the CVT and the ABPM. (Figure 1) A significant average increase of inaccuracy in blood pressure measurement was observed when every health care provider wore a white lab coat. (Figure 1-4) An explanation for these results may be that individuals may develop more stress and anxiety when a professional sporting a white lab coat assesses their BP. This coat may be a contributing factor to the erroneous rise in BP.

Age and gender of the participant had limited impact on the prevalence of white coat hypertension; however inaccurate blood pressure measurements were more common in those with hypertension for more than one year, and in the normotensive population. (Figure 5) Readings of those with hypertension for more than one year were significantly more accurate, and the impact of the health care provider and their attire was minimal. (Figure 5) This may be because normotensives or those with hypertension for less than a year would have significantly less yearly blood pressure readings than those who have developed hypertension for more than one year and thus may be less comfortable with BP readings and be more intimidated or anxious about having their BP measured. (Figure 5) Those with high school education also experienced a higher degrees and prevalence of blood pressure measurement inaccuracy compared to those with college education. Perhaps people with less education may be more intimidated by health care providers. (Figure 5)

CONCLUSIONS:

The data suggest that cardiologists are most prone to causing white coat hypertension compared to nurses or CVTs. It is therefore advised that alternate healthcare providers check BP to minimize the risk if erroneous BP readings and reduce the risk of white coat hypertension. It was observed that cardiovascular technicians caused the smallest BP increase compared to control ABPM readings and therefore caused the least white coat Hypertension. There was no statistically significant difference in BP readings between the cardiovascular technician while wearing normal attire, and the daytime readings from the 24 hour A BPM. This suggests that the occupation or stature of the healthcare provide may influence the BP readings obtained.

BP readings were significantly higher when any of the healthcare providers wore a white lab coat. This suggests that attire of the healthcare provider has an impact on the BP readings. It is advisable for healthcare providers to wear day-to-day clothing instead of occupation-specific clothing that categorizes the professional when measuring blood pressure to reduce erroneous results.

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REFERENCES:


