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Implementing Modified AHA Criteria in the Measurement of Blood Pressure in UConn's Migrant Farmworker Clinics

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Implementing Modified AHA Criteria in the Measurement of Blood Pressure in UConn's Migrant Farmworker Clinics

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Introduction:

Hypertension, a common health condition in which one's blood pressure is too high, affects approximately 32% of American adults over the age of 20. It causes a myriad of poor health outcomes, including an increased risk for stroke and heart attack (Centers for Disease Control and Prevention [CDC], 2016). Clinicians diagnose it through a standardized measurement and protocol. When diagnosed, it can be easily and effectively treated. However, this is not always possible because of the variety of settings and populations in which clinicians measure blood pressure, some of which are more challenging than others. Measuring blood pressure in migrant farmworkers is one such situation. When challenges arise, the standard guidelines used to measure blood pressure are nearly impossible to follow, and deviating from them is more likely to overestimate blood pressure, leading to over-diagnosis (Pickering et al, 2005). Measuring blood pressure properly and diagnosing hypertension with high specificity and sensitivity is especially important in vulnerable populations, such as migrant farmworkers.

This research focused on hypertension in migrant farm workers, as measured at the University of Connecticut's Migrant Farm Worker Clinics (MFWCs). At the MFWCs, the blood pressure measurements are taken in the field and often do not always follow the strict and time-consuming criteria set by the American Heart Association (AHA). Furthermore, while the clinic tries to provide continuity, it is usually not possible to monitor blood pressure multiple times, as is recommended. Throughout the summer and fall, the travelling clinic may visit the same farm up to two to three times, but not all patients return, so doctors must decide whether to diagnose hypertension based on one

clinical encounter. The assignment of such a diagnosis can have extensive effects, including an increased risk for stroke and heart attack, financial burdens of paying for medication, and lifestyle constraints of taking daily pills and multiple medical appointments. Therefore, medical providers should only diagnose those who truly have hypertension in order to avoid those effects. The goal of this study, then, will be to determine whether or not implementation of modified AHA criteria is sufficient to make a meaningful difference in the number of patients diagnosed with hypertension in settings where screening conditions are not optimal and follow-up is uncertain.

Background and Significance:

Many factors increase a patient's risk of developing hypertension, such as family history, diabetes, obesity, a high-salt diet, drinking alcohol, smoking cigarettes, and physical inactivity (CDC, 2014). These factors are prevalent among migrant farmworkers (Castañeda, Rosenbaum, Holscher, Madanat, & Talvera, 2015). If left undiagnosed, hypertension can be deadly. Known as one of the most treatable types of heart disease, patients diagnosed with hypertension today have an excellent prognosis (Turner et al, 2008). However, if the diagnosis is missed, uncontrolled hypertension can destroy the human body. Hypertension is a major risk for developing problems like kidney disease, heart attack, heart failure, and stroke (Piper et al, 2014). According to CDC data, hypertension was implicated as a primary or contributing cause in the deaths of 410,000 American citizens in 2014 (CDC, 2014). There also is evidence that hypertension's burden on the healthcare system is continuing to rise. Even in five years, visits to the emergency department for hypertension and its complications have risen from 71.2/100,000 people in 2006 to 84.7/100,000 people in 2011 (Madhur, 2014). The

healthcare costs due to uncontrolled blood pressure are estimated to be $93.5 billion dollars annually (Hall, Lee, Clark, & Perilla, 2016). Not only does this burden the healthcare system, it disadvantages the patients who are trying to access the system.

After weighing the risks and rewards of conducting high blood pressure screening, in 2015 the United States Preventive Services Task Force (USPSTF) concluded "with high certainty that the net benefit of screening for high blood pressure in adults is substantial." Screening for high blood pressure is also a high-yield process; roughly 75 million Americans have hypertension (Madhur, 2014). For these reasons, screening the population for hypertension is now a standard component of routine clinical care, even required in most cases.

Although measuring blood pressure is important in every patient, it is especially so in migrant farm workers. These workers have many factors that burden their health, including "low socioeconomic status, low education levels, poor housing, migration patterns, cultural barriers, discrimination, poor health care access, and daily struggles with stressful life events" (Hall et al, 2016). All of these factors combine to create a health picture that is one of the most worrisome in the United States of America. In this country, many patients treated at clinics are undocumented immigrants, who fear seeking healthcare more than any other group due to well-founded worries of deportation, discrimination, and other legal issues (Hacker, Anies, Folb, & Zallman, 2015). Because of this fear, many migrant farm workers avoid presenting to a doctor's attention until their pathology is quite advanced, placing them at elevated risk for the complications of all types of diseases and injuries, including hypertension.

According to a study by Bogess and Bogue (2016) in the *Journal of Health Care for the Poor and Underserved*, hypertension was the most common diagnosis among migrant and seasonal agricultural workers with a prevalence of 16.5%. The authors speculated that this number may be artificially low due to underdiagnosis. For comparison, CDC data estimates the prevalence of hypertension in men aged 20-34 at 11.1%, the prevalence in males aged 35-44 at 25.1%, and the prevalence in men aged 45-54 at 37.1% (2016). However, the healthy worker effect might be accountable for some of this disparity as well (Shah, 2009). Hypertension can be difficult to diagnose in this population, as they are vastly underserved in receiving healthcare. If the diagnosis is missed at the MFWCs and these patients go on to develop symptoms, their options for accessing healthcare are limited.

If hypertension could be successfully diagnosed with proper measurement, it would then have the potential to be managed through taking medications, which are frequently prescribed by the MFWCs. There is overwhelming evidence that hypertension is eminently treatable (James et al, 2014). Beyond medicine's mere ability to treat it, it is widely accepted that treating hypertension yields clinically significant results, namely reduction of major adverse events and death (James et al, 2014). Because we can diagnose hypertension, treat it effectively, and help patients to live longer and healthier lives, it is irresponsible not to conduct blood pressure screening as part of primary care services. However, when measurement is done incorrectly, it too can have consequences. Erroneously assigning the lifelong diagnosis of hypertension to a patient can increase his healthcare costs and endanger his life. This is true for migrant farmworkers as well, because UConn's clinics participate in a country-wide network to track migrant

farmworkers' chronic diseases, so their diagnosis of hypertension can follow them for life. To address this problem, the AHA has developed a set of recommendations called the "AHA Criteria."

The AHA guidelines, as described by the authors of the AHA's statement (Pickering et al, 2005), cover the following domains: subject preparation, choice of blood pressure measurement device, cuff size, patient's body position, patient's arm position, how many arms to measure, cuff and stethoscope placement, inflation and deflation system, observer, and number of measurements.

The first factor that the AHA Criteria account for is preparation of the patient. Pickering and his colleagues (2005) noted that "room temperature, exercise, alcohol or nicotine consumption, positioning of the arm, muscle tension, shoulder distention, talking, and background noise" are all variables that can affect the blood pressure reading. According to the guidelines, to prepare the patient, the clinician should ask him about previous exposures to alcohol, smoking, and exercise, and then ask him to relax. For instance, smoking one cigarette within 30 minutes of blood pressure measurement has been estimated to raise systolic blood pressure by 20 mmHg (Kaplan, 2017). Alcohol is thought to raise blood pressure by 5 to 10 mmHg (Hussain, Ansari & Ferder, 2014). Background noise should be minimized as much as possible during the measurement, and there should be no talking during the measurement by either the clinician or the patient.

The AHA also specifies several things about the technical measurement of blood pressure. The traditional "gold standard" has been to use a mercury sphygmomanometer, or at least to use this to standardize another type of sphygmomanometer. However, concerns have been raised about mercury poisoning and these instruments are

consequently being removed from use. In today's practice, a gold standard measurement would be the highly invasive procedure of placing an arterial line or the expensive and inconvenient option of providing each patient with an ambulatory blood pressure cuff, both of which are impractical in the average population. Regardless of which type of sphygmomanometer is used for the measurement, cuff size remains an important consideration. According to the AHA, "the 'ideal' cuff should have a bladder length that is 80% and a width that is at least 40% of arm circumference." This means that clinicians would ideally measure a patient's arm circumference and use that to choose a cuff size. The options for cuff size are "small adult," "adult," "large adult," and "adult thigh" size. The AHA then provides a table of which cuff size to select based on arm circumference. Most clinicians, however, do not have time to measure every patient's arm circumference before taking blood pressure, so they tend to estimate the cuff size. This is complicated by the fact that the population of the United States has been increasing in BMI over the past few decades, increasing the average arm circumference of patients and often leading clinicians to consistently underestimate when choosing cuff size (Pickering et al, 2005).

The next factor that plays a role in obtaining an accurate blood pressure measurement, according to the AHA, is how the patient is situated. Typically, the patient is positioned sitting down, preferably on a chair (not on the exam table). This is because he needs to have his back supported and his feet flat on the floor. Failing to support the patient's back has been attributed to a rise of 6 mm Hg in the patient's diastolic blood pressure, and having him cross his legs is thought to increase systolic blood pressure by between 2 to 8 mm Hg (Pickering et al, 2005). Next, the clinician should attend to the patient's arm position. The arm with the cuff on it needs to be at the level of the patient's

right atrium; too high and the patient's blood pressure will be artificially decreased, too low and it will be artificially increased. The magnitude of the distortion can be significant. For every inch the arm is either above or below the level of the right atrium, the patient's blood pressure can change by 2 mm Hg (Pickering et al, 2005). According to the AHA Criteria, the first time a clinician checks a patient's blood pressure, he should make measurements in both arms, and if they are consistently different, the higher number should be recorded.

> When it is time to actually measure the blood pressure, the clinician:
>
> must first palpate the brachial artery in the antecubital fossa and place the midline of the bladder of the cuff (commonly marked on the cuff by the manufacturer) so that it is over the arterial pulsation over the patient's bare upper arm. The sleeve should not be rolled up such that it has a tourniquet effect over the blood pressure cuff. The lower end of the cuff should be 2 to 3 cm above the antecubital fossa to allow room for placement of the stethoscope…recognizing that if the cuff touches the stethoscope, artefactual noise will be generated. The cuff is then pulled snugly around the bare upper arm (Pickering et al, 2005).

The clinician should then inspect the tubing of the stethoscope for deformities and begin to inflate the cuff. He does this by palpating the patient's radial artery and then pumping the cuff until he no longer feels the radial pulse, and then to 30 mm Hg beyond that point. Then the clinician can begin deflating the cuff, but slowly at about 2 mm Hg per second. Faster deflation rates artificially decrease systolic blood pressure and artificially elevate diastolic blood pressure (Pickering et al, 2005).

After measuring blood pressure once, the AHA protocol is to take it at least one more time for a total of two readings. The clinician should wait for one minute at minimum in between those readings. Presuming that the readings are similar to within 5 mm Hg, the clinician should take an average of those numbers and use that as the patient's blood pressure. If the readings are more different, however, then the clinician is

advised to take a few more measurements and average the group to determine the patient's blood pressure. For reference, the medical definition of hypertension is a systolic blood pressure greater than or equal to 140 mm Hg or a diastolic blood pressure greater than or equal to 90 mm Hg.

The AHA further opines that a doctor or nurse does not need to be the one to measure blood pressure, and that volunteers from the community are equally capable of taking accurate blood pressure as long as everyone is trained repeatedly on proper measurement technique. While the person taking the blood pressure is perhaps the most important variable, many clinicians and healthcare volunteers do not follow the guidelines exactly (Ogedegbe & Pickering, 2010). For example, they rarely obtain measurements from both arms and have patients sit in a straight-backed chair. One study from the *American Journal of Hypertension* asked medical students to recall the last time their blood pressure was measured and whether or not it had been done so according to AHA guidelines. Out of 450 medical students, not a single one reported all of the AHA guidelines were followed, but 95% of them still thought their blood pressure had been taken appropriately.The researchers felt that these discouraging results were because the medical students were never actually taught how to take blood pressure according to the AHA guidelines (Grim, Li, and Grim, 1999).

It is well accepted by the scientific community (USPSTF, 2015) that measuring blood pressure according to the AHA's guidelines increases the accuracy of the measurement in a controlled office setting (Pickering et al, 2005). It is difficult to know how the results translate to a mobile medical clinic on farms. Measuring blood pressure among Connecticut's migrant farm workers is vastly more complicated. It is impossible to

control the temperature or noise of the environment in a setting such as a farm. It is also difficult to reduce patients' anxiety, as many are undocumented immigrants and thus find the prospect of presenting for healthcare attention to be risky (Hacker et al, 2015). If the AHA Criteria are implemented to the fullest extent allowable at the MFWCs, will it be possible to get an accurate, clinically useful reading in the field? In the opinion of this author, the AHA criteria should be modified to fit the real-life constraints of a mobile clinic. The intent of this study is to create and implement "Modified AHA Criteria" in the MFWCs. This study aimed to determine if this would aid the doctors in diagnosing hypertension.

Research Objectives:

Given the conditions of the MFWCs and the impossibility of reproducing the full AHA Criteria in this setting, the author of this study developed Modified AHA Criteria and implemented them in the summer of 2017. For the purposes of this paper, "usual practice" is meant to convey the range of variability that encompasses how clinicians and volunteers measure blood pressure in their daily practices. In contrast to the standardized format prescribed by the AHA, in real life people tend to deviate from the guidelines in different ways: many will only measure one arm, or take the measurement over clothes, or take the measurement with the patient sitting on an exam table with his back unsupported and his legs dangling. To understand the design of this study, it is also necessary to understand normal clinic function: these are outdoor clinics, composed of several tables and stools set up in an open, flat area. When patients arrive, they first go to a "registration table" to fill out their basic demographic information and consent to receive care at the clinic. Then they move to a "vitals table" to have their BMI, pulse,

blood pressure, and blood glucose measured. There, they wait for placement into a "medical team" that conducts the visit and establishes diagnoses and treatment plans. The patients finish at the pharmacy, where they receive medications.

Consequently, this research proposed to implement the Modified AHA Criteria in a way that would be feasible for the MFWCs. As part of the study design, the volunteers would take blood pressure readings according to usual practice. If the patient was hypertensive, the patient and volunteer would move down to the end of that table, where the Modified AHA Criteria were posted. The volunteer would then repeat the blood pressure measurement according to these criteria. The decision was made to only include the patients flagged as hypertensive because the original AHA Criteria have each been individually verified to produce a lower and more accurate reading, and therefore the concern was over-diagnosis, not under-diagnosis. The question was then how many people had another high blood pressure reading and how many would have a lower reading when taken according to the modified guidelines. Basically, it aimed to determine how many people would have been diagnosed with hypertension under usual practice but not with the Modified AHA Criteria, and to compare measurement results from typical practice to the Modified AHA Criteria. The hypothesis was that the Modified AHA Criteria would produce a lower mean blood pressure reading than the usual practice measurements, and the null hypothesis was that there would be no difference between the measurements.

Methodology:

The study design was a two group comparative observational study with convenience sampling. The two groups refer to the division of study participants into

"usual practice" and "Modified AHA Criteria" groups, but these did represent the same collection of patients. It compared the results of the Modified AHA Criteria to those obtained from usual practice blood pressure assessment in a sample of MFWC patients. The target population was any patient who came to the clinic, was aged 18 or older, spoke Spanish or English, and had received a hypertensive reading of greater than or equal to 140 mm Hg systolic or greater than or equal to 90 mm Hg diastolic when taken according to usual practice. Every patient from every farm on the 2017 UConn MFWC Schedule who met these criteria was included in the study, during in a time period of June 15th through October 11th.

The study began when patients arrived at the clinic. As part of receiving care, they were directed through various stations, the first of which was a "registration table." The volunteers at this station completed the informed consent process with each patient and the patients received a handout on the study. The next station is a "vitals station," staffed by community members trained by UConn medical students to record the patients' blood pressure, blood glucose, pulse, and BMI. If the blood pressure reading met hypertension criteria and the patient had consented, then the volunteer would move down the table, read the Modified AHA Criteria available on the table and follow the directions to repeat the blood pressure. The results of their modified blood pressure measurements were written in their medical chart and then de-identified and recorded in a separate study sheet. Next, the patient would move to the treatment team composed of a medical student, the pharmacist, and an attending, who would decide how to address the hypertension. Based on the modified and usual practice readings, they would determine whether or not to prescribe anti-hypertensive medication for the patient.

All of the volunteers measuring blood pressure had attended one training session by UConn medical students before the clinic season commenced, and the "Modified AHA Criteria" checklist was taped onto the vitals station. Volunteers were either observed by the author of this study or by an undergraduate coordinator who had been instructed by this author. This aimed to ensure that the volunteers were following the modified guidelines properly.

The Modified AHA Criteria were created by the author of this study and included all of the AHA Criteria that were feasible to incorporate in an outdoor, mobile clinic. The table below compares the AHA Criteria to the Modified AHA Criteria. To see the modified criteria as they were presented to the volunteers, please refer to the Appendix.

Table 1. Differences between the AHA Criteria and the Modified AHA Criteria

	AHA Criteria	Modified AHA Criteria
Before measuring blood pressure, ask about recent exercise, alcohol use, nicotine use	X	X
There is no background noise	X	
The room is a comfortable temperature for the patient	X	
Patient and clinician do not talk during blood pressure measurement	X	X

Patient is seated in straight-backed chair	X	
Patient is seated for 5 minutes before first blood pressure measurement is taken	X	
Patient's feet are flat on the ground and not crossed	X	X
Patient's arm is measured to select cuff size	X	X
Measurement is taken on patient's bare skin	X	X
Patient's sleeves are not rolled up in a tourniquet fashion	X	X
Patient's arm is supported at the level of the right atrium	X	X
Patient's radial artery is located in the arm in which blood pressure is being measured, and the cuff is inflated until the pulse is not palpable, and then 30	X	X

mmHg beyond that		
Stethoscope is positioned just below the blood pressure cuff	X	X
The cuff is deflated at a rate of 2 mmHg per second	X	X
The cuff is removed for one minute, and then placed on the patient's other arm, which is measured with the same steps	X	X
If the readings are different by more than 5 mmHg, remove the cuff for one minute and measure the first arm again	X	X

This list obviously differs from the actual AHA guidelines in a few ways, but it is a more standardized system than permitting each volunteer to measure according to their usual practice, and this author believes that it is a compromise that will function in the real-world setting of an outdoor clinic.

Analysis:

There were two different variables in this study: the blood pressure measurements taken according to usual practice and the measurements taken according to the Modified AHA Criteria. The raw data are blood pressure readings for each patient – the initial hypertensive value followed by subsequent values obtained with the modified guidelines. The systolic and diastolic results for the usual practice and the Modified AHA Criteria were pooled and averaged. A one tailed t-test was used to test whether the mean of the Modified AHA Criteria measurements would be lower than the usual practice measurements. Count data were also employed to see how many patients were initially hypertensive but were re-classified as normotensive when measured with the Modified AHA Criteria.

Human Subjects:

The human subjects in this study were at minimal risk, both to their health and their privacy. In terms of their health, patients assumed no additional risk – they were still treated at the clinic according to normal practice. The only change was in the amount of times their blood pressure was measured, and while these additional five to ten minutes might have caused a slight time inconvenience, the act of getting one's blood pressure measured is not inherently dangerous at all. In fact, these patients might have actually received better care and experienced a reduction in their health risks, as they benefitted from more accurate blood pressure measurement, and therefore improved treatment.

In terms of risks to confidentiality, the patients did not incur more than they already have as patients of the clinic. Every patient who arrived at the clinic was consented for the study in either English or Spanish as they registered (consent form can be found in the Appendix), and given a sheet explaining the purpose of the study in both English and

Spanish. Their blood pressure measurements were de-identified by the vitals station volunteers who were HIPAA-trained and collected on a sheet separate from their medical record. The researcher never knew the Protected Health Information (PHI) of any of the patients. Their additional blood pressure numbers were also reported on their chart, where the information could aid the medical team in treatment. Therefore, in addition to acquiring no further health or privacy risks, the human subjects of this research benefitted from more thorough medical care. This study was approved by the University of Connecticut Health Center Institutional Review Board.

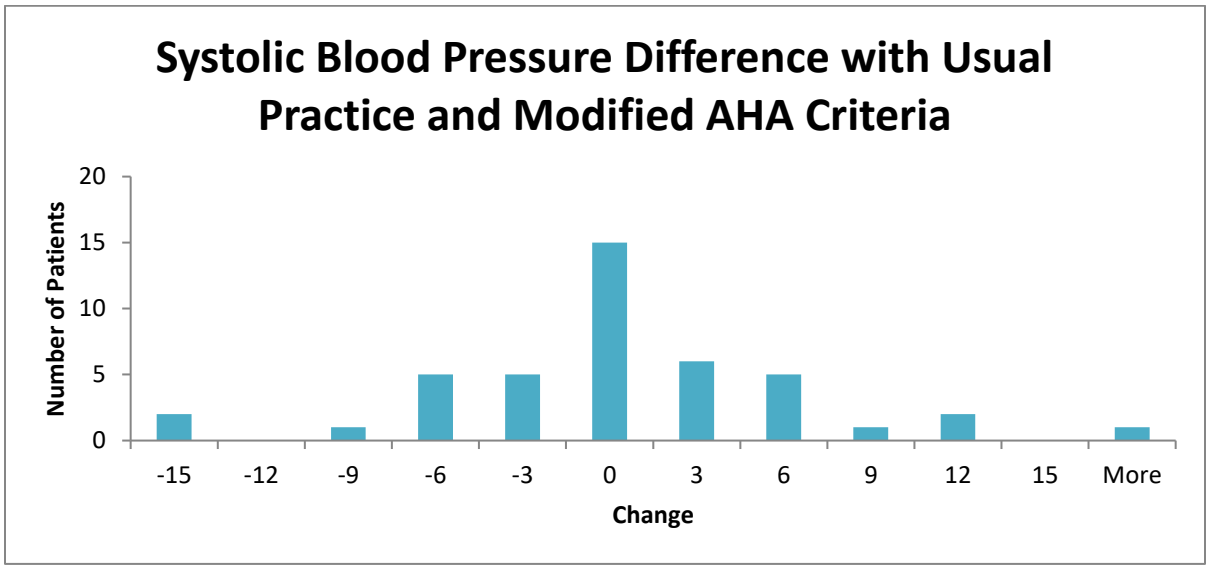
Results:

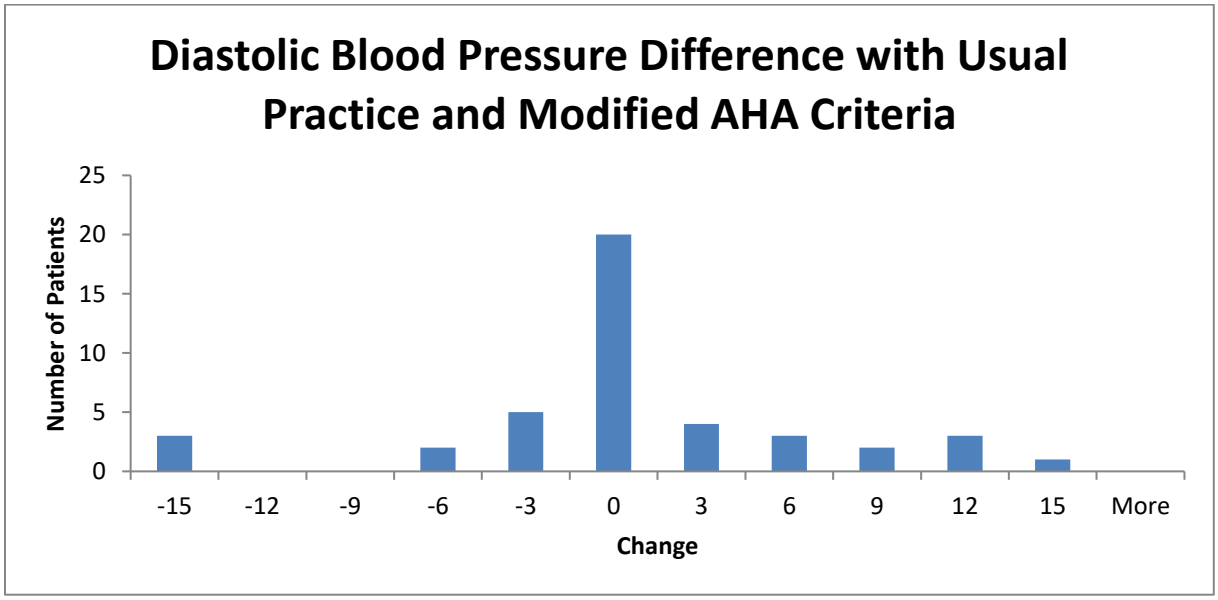
The final sample size was 43 patients, all male and aged 18 or older. Further discussion of the sample demographics or determination of the prevalence of hypertension in this population is not possible because of steps taken to protect patient confidentiality. The raw data can be found in the Appendix. Table 2 below illustrates the usual practice measurements and the modified AHA criteria measurements. There are three columns for the modified measurements because the study protocol required obtaining two blood pressure readings, one on each arm, and then these measurements were averaged to create the patient's modified AHA criteria blood pressure measurement.

Table 2. Comparison of Usual Practice and Modified AHA Criteria Results

	Usual Practice BP (n=43)	**Initial Modified AHA Criteria BP (n=43)**	**Next Modified AHA Criteria BP (n=39)**	**Modified AHA Criteria BP (n=82)**
Mean	151.44/90.16	150.37/89.09	151.97/90.02	151.13/89.55
Median	150/90	150/90	150/90	150/90
Standard Deviation	11.46/11.94			12.93/10.71
P value				0.89/0.76

Figure 1: Change in Blood Pressure When Measured With Usual Practice and Modified AHA Criteria





The above histograms in Figure 1 show the raw data – each patient was grouped by the change between their initial blood pressure and their average study blood pressure.

One patient was initially hypertensive, but both subsequent study measurements reclassified him as normotensive. This means that 2.32% of the study population may

have been falsely diagnosed with hypertension without implementation of the Modified AHA Criteria.

Discussion:

Analysis of the data was two-fold: the t-tests analyzed the overall means on a group level, and the count data focused on the patient level. As evidenced above, the p-values did not demonstrate statistical significance. Therefore, the null hypothesis that there would be no difference between blood pressures measured with and without the Modified AHA Criteria was not rejected. This was supported by the fact there was no change between the medians of the usual practice and the Modified AHA Criteria. While the mean systolic and diastolic blood pressures were indeed lower when measured with the criteria, it was by less than a point for each. Based on the Pickering et al. data that the each of the AHA Criteria used in this study do produce more accurate readings individually, this could represent a move towards the patients' baseline blood pressures. However, this difference was small and could have been due to chance. From this perspective, it would not make sense to implement the criteria for all of the clinic patients because the numbers derived using the Modified AHA Criteria are close enough to the usual practice results to make no statistical difference.

However, when the count data was analyzed, there was one patient for whom the criteria did make a difference. This patient was initially classified as hypertensive (at 140/70) but both subsequent measurements were lower (136/70 and 134/70). Therefore, he no longer met the definition of hypertension, and was presumably not treated by the medical team. For this patient, the very slight difference in accuracy employed by the Modified AHA Criteria was important, because he was just on the border of being

hypertensive. Therefore, a reasonable suggestion would be to implement the Modified AHA Criteria on those patients who barely meet the definitions of hypertension - perhaps those with blood pressures between 140/90 and 144/94. Thus, the MFWCs might benefit more from a two-step screening process, in which first all patients have their blood pressure measured according to usual practice, and then if found to have a borderline hypertensive result, they are measured again with the modified AHA criteria. There, all patients receive a high sensitivity screening measurement, but those that are borderline receive a subsequent measurement taken with the intent to achieve higher specificity. This approach would aim to minimize the false positives (patients who have a hypertensive measurement while not being truly hypertensive when measured according to a gold standard) and thus overall increase the specificity of diagnosing hypertension at the MFWCs. A concern would be false negatives (patients who had a normal blood pressure measurement but who would have been hypertensive if measured with a gold standard), however as previously discussed, the biases in measuring blood pressure according to usual practice guidelines predominate towards overdiagnosis, not underdiagnosis (Gordis, 2013).

Anecdotal evidence from the staff working the clinics was that these guidelines were reasonable and did not unnecessarily burden the clinic. In terms of clinic flow prior to the implementation of these guidelines, patients would move swiftly from the registration table to the vitals table, but would then need to wait there for placement into a medical team. Therefore, adding an additional step to the vitals table made sense, in that it used downtime to collect useful patient information for the medical team, and it did not contribute to longer wait times for patients. Medical staff did not have to return to the

vitals station to acquire more blood pressure readings before deciding whether or not to treat a patient. The clinic's coordinator commented that many doctors had said that they found the additional numbers and data about recent alcohol, nicotine, and exercise useful as well. Therefore, this study also served as a quality improvement project to improve future blood pressure measuring in the clinics. It also suggested that usual practice measurements are reasonable to use, as they obtained similar results as the standardized approach.

This study is not immune from limitations, the first being that the researchers were unable to control the sample size. This season the clinics did not have as many patients as previous years, resulting in this study's conclusions having a low power. However, given that the p values were not close to statistically significant, it is highly unlikely that the power would have changed this. Another limitation is that the design of this study does not allow for a control group or another way to standardize results, as implementing the modified guidelines on all patients would be too burdensome time-wise. Ideally, the best way to do this would be to give each hypertensive patient a wearable blood pressure monitor to determine their "true" blood pressure throughout the next day, but financial and situational limitations prevented that. Time constraints prevent implementation of the modified AHA criteria on all patients – regardless of blood pressure – as it would be burdensome to the clinic's volunteers to replicate, and without knowing beforehand if it is a burden that provides clinical benefit, it could not be justified. Also, there is the distinct possibility that results could have been confounded by the volunteers being presented with a list of how to appropriately take blood pressure. Even though they were instructed to take it as they normally would for the first

measurement, they could have been biased by the experience of subsequently taking it according to the guidelines with their previous study patients. Also, the experience of having one's blood pressure taken multiple times could have caused further anxiety and caused the later measurements to be artificially elevated. Future research should compare the Modified AHA Criteria to the original AHA Criteria to determine if they have similar accuracy, as well as compare MFWC usual practice to usual practice in the real world, where clinicians are more remote from training.

Conclusion:

In conclusion, the Modified AHA Criteria did not produce a statistically significant drop in blood pressure measurements. However, they did produce a slight decrease of less than one point in both the systolic and diastolic, which allowed one patient to avoid the diagnosis of hypertension. The Modified AHA Criteria were also easily implemented by the clinic and well-liked by staff. Therefore, it is reasonable to continue to use the criteria, but only for those patients that are narrowly hypertensive. As they did not slow clinic flow, they could also continue to be used at the discretion of the doctors working that evening's clinic, as many liked having additional data points when making treatment decisions. Even those who, according to the guidelines, did have hypertension incurred some benefit by having additional data. In these cases, newly-diagnosed hypertensives – and their providers – could feel more confident in their diagnosis and focus on their subsequent plan of care and recommendations for lifestyle modifications.

Even in the absence of statistically significant results, this study benefited the UConn Health MFWCs in that it allowed volunteers to be a bit more cognizant of the

guidelines for measuring blood pressure. Furthermore, discussing the results of this study can help to raise awareness of the problems encountered by non-traditional clinics attempting to measure blood pressure such as clinics that work out of homeless shelters and soup kitchens.

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Appendix:

Modified AHA Criteria

1. Ask patient if he has recently exercised, drank alcohol, or used nicotine-containing products. If so, record this on the sheet but continue to follow the criteria.
2. Position the patient so that he is seated on the stool with his back against the table and his feet flat on the ground.
3. Measure the patient's arm to select the correct cuff size (begin with the arm you did not just use in the preliminary screening).
4. Ensure unobstructed access to the patient's arm, but do not roll up his sleeve such that it puts pressure on his arm.
5. Position the cuff 2-3 centimeters above the patient's antecubital fossa, with the arrow pointing to the center of the fossa.
6. Instruct the patient not to talk during the exam, and remind him that you cannot talk either.
7. Hold the patient's arm at the level of high right atrium, making sure to support it with your arm.
8. Locate the patient's radial artery in the arm in which you are measuring the blood pressure.
9. Inflate the cuff until you no longer feel his pulse, and then inflate it 30 mm Hg beyond that point.
10. With your stethoscope in your ears and placed just below (not touching) the cuff, begin listening for the Korotkoff sounds.

11. Deflate the cuff at a rate of 2 mm Hg per second.
12. Remove the cuff from the patient and record the number on the study sheet and on the patient's encounter sheet.
13. Wait one minute.
14. Repeat steps 4-12 on the patient's other arm.
15. If the readings are similar to within 5 mm Hg, average the two numbers and record that final number in both the study sheet and the patient's encounter sheet. If the readings are different by more than 5 mm Hg, wait one more minute and measure the first arm again. Record that number on both sheets.

Consent Form in English (was also translated into Spanish):

Dr. Bruce Gould (Principal Investigator) and Alexandra Turgeon (UConn medical student) are conducting a study at the Migrant Farmworker Clinic to improve how we measure blood pressure, called "**Implementing Modified AHA Criteria in the Measurement of Blood Pressure in UConn's Migrant Farmworker Clinics**." We are conducting this study to determine if following Modified American Heart Association Criteria to measure your blood pressure will help volunteers at UConn's Migrant Farmworker Clinics to better diagnose high blood pressure in a mobile setting.

As part of the standard of care at this clinic, we measure the blood pressure of every patient. This study will only apply to people whose initial blood pressure measurement is high (this means a top number of greater or equal to 140 or a bottom number of greater than or equal to 90). If this is you, and you agree to be in the study, first we will ask you questions about things you might have done recently (exercised, drank alcohol, or used nicotine), and then we will measure your blood pressure again a 2-3 more times, doing so in a slightly different manner (we will still use a cuff that goes around your arm, but we will have you sit in a different chair and position your body differently and we will ask you not to talk while we are measuring your blood pressure).

This process should not take more than 5 minutes, and we will record both your standard-of-care blood pressure measurement and also your study measurements on a separate data sheet (as well as whether you've exercised, drank alcohol, or used nicotine), but it is an anonymous form, meaning that we will not record your name or any other personal information about you.

This information will allow us to figure out the best way to measure blood pressure, in the hopes that we can do this better in the future to more accurately diagnose people with high blood pressure.

Participation in this study is voluntary and you can stop at any time, but allowing us to measure your blood pressure more than once implies your consent.

This study is being conducted by Alexandra Turgeon and Dr. Bruce Gould, with the intent to use these results to improve how these clinics measure blood pressure. Alexandra will also use them for her thesis. For any questions, please contact Alexandra at 860-428-5075 or Dr. Gould at 860-679-4223.

Raw Data with Usual Practice and Modified AHA Criteria Measurements:

Patient #:	Usual Practice BP:	Initial Modified AHA Criteria BP (indicate arm)	Next Modified AHA Criteria BP	Has patient recently exercised, drank alcohol, or used nicotine? If yes, specify which.
1	142/72	148/82	148/82	2 days ago alcohol
2	160/90 (left)	150/90 (right)	150/85 (left)	Yes – drank + smoked
3	138/98 (right)	138/98 (left)	140/98 (right)	No
4	140/70 (right)	136/70 (left)	134/70 (right)	No
5	160/80 (right)	160/85 (left)	156/80 (right)	Yes
6	154/86	158/86	156/86	No
7	145/90	140/80	143/85	
8	142/68 (right)	128/68 (left)	144/88 (right)	No
9	163/80	164/82	162/79	No
10	150/90 (right)	140/90 (left)	145/90	Quit smoking 1.5 years ago
11	140/90	140/90		No
12	144/86 (left)	146/84	150/96	No

13	168/90 (right)	162/90 (left)	166/86 (right)	No
14	164/100 (right)	162/110 (right)	164/112 (left)	Smoke
15	152/98 (left)	152/96 (right)	154/96 (left)	Alcohol ?smoked nicotine
16	148/90 (right)	144/86 (right)	140/82 (left)	No
17	134/96 (right)	126/94 (left)	126/94 (right)	
18	150/100 (right)	150/98 (right)	158/100 (left)	
19	150/92 (right)	150/86 (left)	146/88 (right)	No
20	140/88 (right)	148/92 (left)	138/90 (right)	4 days ago, 3 beers
21	145/105 (left)	145/100 (right)		1 beer, 7 hours ago
22	150/96 (left)	150/100 (right)	154/108 (left)	30 minutes ago smoked one cigarette + 4 beers
23	170/110 (left)	[1]151/96 (right)	160/110 (left)	"work is exercise"
24	150/90 (right)	150/94 (left)		No
25	140/85	140/85	140/85	Yes, cigarette smoker
26	140/90	140/90		No smoking
27	140/80	150/80	145/80	No cigarettes or alcohol
28	146/90 (right)	142/90 (left)	140/90 (right)	Yes, exercise
29	162/92 (left)	144/90 (right)	142/94 (left)	No
30	142/80	142/80 (left)	150/84 (right)	Exercise – yes. No to nicotine. Alcohol – yes ½ hour ago.
31	170/80	185/90	178/100	Exercise
32	144/92 (right)	144/90 (left)	144/94 (right)	No
33	162/105	160/105 (right)	165/105 (left)	No

34	164/72	162/70 (right)	160/70 (left)	Exercise → work 1 beer this evening
35	170/100	178/100 (right)	170/100 (left)	Exercise; drink alcohol
36	142/90 (right)	138/86 (left)	142/84 (right)	No
37	150/90 (right)	145/95 (left)	150/85 (right)	Yes, working
38	142/90 (right)	146/98 (left)	138/98 (right)	Yes, work
39	170/94 (right)	158/90 (left)	168/90 (right)	Yes, work
40	140/90	150/70 (left)	150/70 (right)	
41	152/68 (right)	152/78 (left)	150/70 (right)	No
42	182/134 (left)	180/120 (left)	180/110 (right)	No
43	150/100 (left), 160/100 (right), average 155/100	181/93 (right)	181/97 (left)	Yes

1: This represents the average of two right-sided blood pressure measurements taken according to the Modified AHA Criteria. The first measurement was 142/80 and the second measurement was 160/112.