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ORIGINAL ARTICLE

Knowledge of accurate blood pressure measurement procedures in chiropractic students

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Objective: Blood pressure measurement is a basic clinical procedure. However, studies have shown that many errors are made when health care providers acquire blood pressure readings. Our study assessed knowledge of blood pressure measurement procedures in chiropractic students.
Methods: This was an observational, descriptive study. A questionnaire based on one created by the American Heart Association was given to 1st, 2nd, 3rd, and final year students ($n = 186$). A one way ANOVA was used to analyze the data.
Results: Of the students 80% were confident that their knowledge of this clinical skill was adequate or better. However, the overall score on the knowledge test of blood pressure–taking skills was 52% (range, 24%–88%). The only significant difference in the mean scores was between the 1st and 2nd year students compared to the 3rd and 4th year students ($p < .005$). Of the 16 questions given, the following mean scores were: 1st year 10.45, 2nd year 9.75, 3rd year 7.93, and 4th year 8.33. Of the 16 areas tested, 10 were of major concern (test item score <70%), showing the need for frequent retraining of chiropractic students.
Conclusion: Consistent with studies in other health care disciplines, our research found the knowledge of blood pressure skills to be deficient in our sample. There is a need for subsequent training in our teaching program.

Key Indexing Terms: Blood Pressure; Chiropractic; Knowledge

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INTRODUCTION

Cardiovascular disease is the leading cause of mortality in the United States. The American Heart Association reported in 2003 that over 65 million Americans suffer from hypertension.[1] With the increasing demand for evidence-based chiropractic care and the effect of chiropractic manipulation on patients with hypertension reported by Bakris et al.,[2] it is imperative that all chiropractic students be well-versed in the correct method for assessing blood pressures. This is in harmony with the Council on Chiropractic Education accreditation standards meta-competency 1 to perform properly an initial assessment and diagnosis of the patient.[3] The accurate measurement of blood pressures by chiropractic students is assumed upon completion of this area of study in their education. Currently, chiropractic students in our college learn how to measure blood pressure during the beginning of their 1st year of training. Their proficiency is tested at the end of the 1st quarter.

Blood pressure measurement is a basic clinical procedure. However, numerous studies have shown that many errors are made from the incorrect performance of procedures.[4] Observation of other health professions' literature suggests that measurement techniques may be out of line with current recommendations in various health care fields.[4–9] For example, one study showed that many physicians did not have the patient rest at least 5 minutes before the blood pressure measurement,[5] and another showed that few physicians, if any, followed the American Heart Association guidelines when measuring blood pressure.[6,7] A final report showed that physicians used improper cuff sizes.[8] Although to our knowledge there have been no studies of the blood pressure assessment skills of chiropractic students, we have postulated that the skills of chiropractic students would be no different from those of other health care professionals. Some of the many technical errors include using the wrong cuff size, or improper patient or arm positioning.[10] We used a knowledge test of skills to assess the current knowledge of our chiropractic students.[11,12]

METHODS

The knowledge test of blood pressure measurement skills was developed from a questionnaire crafted by the

Table 1 - Descriptive Statistics of the Sample Used in This Study

	Y 1	Y 2	Y 3	Y 4	Totals
Male	18	33	19	37	107
Female	19	28	11	21	79
Age 20–30	28	53	26	55	164
Age >30	10	8	4	3	22
Caucasian	28	51	22	47	148
Hispanic	1	3	1	3	8
African American	3	3	6	4	16
Other	5	4	1	4	14
Students with bachelor degrees only	35	61	27	55	178
Students with master's degree	2	0	2	3	7
PhD	0	0	1	0	1
Totals	37	61	30	58	186

Wisconsin Heart Disease and Stroke Prevention Program[12] and from a survey instrument developed for nurses in Australia,[13] both of which were based on the American Heart Association 2005 guidelines.[14] The test items were piloted on a small group of 2nd year chiropractic students. The finalized test included demographic and educational questions. Before answering the 16 test items, participants were asked to indicate on a Likert-type scale their level of confidence in the adequacy of their skills for accurate blood pressure measurement. The full survey is available online as a supplemental Appendix to this article.

Approval by our college institutional review board was obtained before conducting this research. A convenience sample was taken from 1st, 2nd, 3rd, and 4th year chiropractic students at the Palmer College of Chiropractic Florida campus. We independently processed the information collected from the questionnaire. The maximum attainable knowledge score was 16. A one-way ANOVA using SPSS 15.0 (SPSS Inc, Chicago, IL) was used to test for significant differences among the four groups. Levene's test of homogeneity of variance was used to verify whether the four groups' variances were equal or not. The test–retest method was used to see if there was internal consistency.

RESULTS

A total of 186 students participated in the study, constituting 68% of the total student enrollment ($n = 274$) at our college during the period of the study. Demographic data can be seen in Table 1. Of the 186 students participating in the study, 80% were confident about their knowledge of blood pressure measurement skills (agreed or strongly agreed), 15% were unsure, and 5% were not confident about their knowledge (Table 2). The mean score was 52% with a range of 24% to 88%. Table 3 shows a detailed breakdown of how the students performed on each of the questions in the test. Levene's test of homogeneity of variance was used to verify whether the four group variances were equal. The results did not show significant differences ($p > .05$), indicating that the four groups in the study could be considered equal. The one-way ANOVA showed statistically significant differences in the years 3 and 4 groups (Table 4). The distribution of the scores for individual items for the four groups of participants varied from item to item, showing a decay in knowledge when compared to years 1 and 2. There were no significant differences between the overall scores of the 1st, 2nd, 3rd, and 4th year students. Of the 16 questions given, the mean scores for 1st, 2nd, 3rd, and 4th year students were 10.4, 9.7, 7.9, and 8.33, respectively (Table 5). The decay in the knowledge between the 1st and 2nd year students was not statistically significant. There was a statistically significant decrease between the 1st two years and the latter two years ($p < .005$). Of the 16 knowledge areas tested in the blood pressure measurement skills test, 11 areas were of major concern (test item score <70%). Table 6 shows a summary of 7 of the above errors, and the

Table 2 - Level at Which Participants Agreed With the Statement, "I am Confident That My Knowledge is Adequate for Accurate Measurement of Blood Pressure."

Level of Agreement	1st Y Students	2nd Y Students	3rd Y Students	4th Y Students	Totals
Strongly agreed	4	7	9	21	41
Agreed	24	33	17	34	108
Unsure	8	21	4	2	35
Disagreed	1	0	0	1	2
Strongly disagreed	0	0	0	0	0
Totals	37	61	30	58	186

Table 3 - Scores for the 16 Items Tested on Blood Pressure (BP) Measurement Procedure Knowledge

	Question	Y 1	Y 2	Y 3	Y 4	Totals
	n of participating students	37	61	30	58	186
1	*n* of BP measurements to be taken each time BP is measured	30	49	21	34	74%
2	BP should be measured in both arms at the initial visit	23	23	27	52	81%
3	Common errors resulting in a higher BP measurement	14	3	5	15	31%
4	Rounding off of systolic BP reading to the nearest 2 mm	8	0	1	6	10%
5	Rate of cuff deflation	32	50	28	53	88%
6	Frequency of retraining of health care professionals in BP measurement	22	35	6	6	37%
7	Selection of correct cuff size	27	35	15	24	54%
8	Time to wait in between BP measurements on the same patient	26	31	10	33	54%
9	In the absence of a hard surface, the patient should hold the arm up	29	45	27	45	78%
10	Permissible to omit the measurement of systolic BP by palpation	35	48	11	26	64%
11	Heard of the American Heart Association guidelines on BP measurement	28	37	16	28	59%
12	Read American Heart Association 2005 guidelines on BP measurement	7	11	3	6	15%
13	Know how to avoid auscultatory gap	22	29	15	38	56%
14	Use bell of stethoscope when measuring BP	33	40	6	13	56%
15	Use Korotkoff phase V to measure diastolic BP	27	52	26	54	49%
16	The patient is on the table when the BP is measured	33	54	25	50	85%

degree of magnitude of the discrepancy of the resulting systolic and diastolic blood pressure recordings.

DISCUSSION

Several items are worthy of discussion, presented below with regard to deficiencies noted in test results and significance of these deficiencies.

Positioning of the Patient

Measuring the blood pressure with the patient sitting on the examination table could result in a higher blood pressure reading, since the patient's arm often is not at the level of the heart on the height of the table. Of the participants in the study 31% had difficulty recognizing this. Some participants thought that the forearm need not be supported with the palm facing up. A smaller number felt that it was wrong to have the patient's back against the chair with the feet flat on the floor.

Rounding Off to the Nearest Number

Only 18% of the participants were aware of how the terminal reading should be recorded correctly. It is recommended by the American Heart Association that the recording should be to the nearest 2 mm Hg when using the mercury and aneroid sphygmomanometers to compensate for rapid and slow heartbeats.[14]

Proper Seating of the Patient

Not many of the participants were aware of the need to have the patient seated properly in a chair with back support and with both feet flat on the ground. Van Velthoven et al. found that sitting with the back unsupported and with the legs crossed will result in an erroneously high blood pressure.[16] If the back is not supported, such as with the patient seated on the examination table, the diastolic pressure may be raised by as much as 6 mm Hg. Crossing of the legs will increase the systolic pressure by 2 to 8 mm Hg.

Correct Positioning of the Arm

Ideally, the arm should be placed on a level with the patient's heart. Placing the arm lower than the level of the heart will result in a higher measurement, while placing it above the level of the heart will result in a lower measurement. Netea et al. reported that for each 5 cm change in arm position relative to the heart there was a corresponding change in blood pressure by 3 to 4 mm Hg.[15]

Selection of Cuff Size

Using an inappropriate cuff size will result in an incorrect blood pressure result, which is something that 55% of the participants did not know. The length and width of the bladder within the blood pressure cuff should be at least 80% and 40% of the circumference of the

Table 4 - Results of One Way ANOVA Analysis Between Groups for All Groups

Source of Variation	*df*	Sums of Squares	Mean Square	*F*	*p*
Group	3	177.35	59.12	17.2	<0.001
Error	182	625.14	3.44	–	–

df, degrees of freedom.

Table 5 - Descriptive Statistics of the Passing Rate of the Chiropractic Students, With the Passing Score Being 12 and the Passing Percentage Being 70%

Groups	*n*	Mean	SD	Minimum	Maximum	% Passed
Y 1	37	10.45	1.82	6.0	13	51
Y 2	61	9.75	2.03	4.0	13	29
Y 3	30	7.93	1.43	5.0	11	0
Y 4	58	8.33	2.08	4.0	14	6

patient's arm, respectively. Too small a cuff will result in a higher measurement.

Avoiding the Auscultatory Gap

Of the students, 49% were unfamiliar with how to avoid the auscultatory gap. The auscultatory gap is a phenomenon that may occur in some patients with very high blood pressures. In this phenomenon, the first Korotkoff sounds may appear, for example, at 220 mm Hg. As the cuff is deflated at the recommended 2 to 3 mm Hg per second rate, the blood pressure sound will disappear in some patients only to reappear at a lower blood pressure, perhaps at 180 mm Hg. If the systolic blood pressure was not determined initially by palpation, one is likely not to inflate the cuff as high as 240 mm Hg (palpatory systolic pressure plus 20 to 30 mm Hg). The patient would appear to have a systolic pressure much lower than that it actually is.

Utilization of the Bell

The bell of the stethoscope generally is recommended when measuring blood pressure and 49% of the participants were unaware of this. This may be a minor issue, however, as recent studies have indicated that there is no statistically significant difference when using the bell or the diaphragm.[17]

Korotkoff Phase V Sounds

It is recommended that Korotkoff Phase V (when the sounds disappear completely) sounds be used when measuring the diastolic blood pressure. Phase IV sounds should be used only if the level of the Korotkoff Phase V sounds is greater than 10 mm Hg above the Korotkoff Phase IV level.

Table 6 - Factors Affecting the Accuracy of Blood Pressure Measurement[17]

Factor	Magnitude of SBP/DBP Discrepancy, mm Hg
Talking or active listening	10/10
Smoking within 30 min of measurement	6–20/–
Back unsupported	6–10/–
Arm unsupported sitting	1–7/5–11
Cuff over clothing	5–50
Cuff is too small	10/2–8
Distended bladder	15/10

Other Interpretations

Our study has shown that our students possess an inadequate level of knowledge regarding the correct procedures for measuring blood pressure. This is not surprising given similar deficiencies in medical, nursing, and pharmacy students worldwide, as shown in Table 7.[9,10,18] If chiropractors are going to be involved in the global fight of reducing the risk of hypertension, then it is imperative that they improve their knowledge of how blood pressure measurements should be done. Although blood pressure assessment procedures may be simplified in the future by the increasing use of automatic devices, it does not mean that healthcare professionals can stop paying attention to factors, such as the position of the patient, the use of the correct cuff size, being seated with uncrossed legs in a chair with a back support, having rested five minutes before the measurement was taken, and not talking while the blood pressure is being measured.

There was a statistically significant difference between the mean scores of year 1/year 2 students and year 3/year 4 students ($p < .05$). This significant decay in blood pressure skills knowledge could be attributed to the fact that there has been no interval retraining of the students in the performance of this skill. In fact, 37% of the students surveyed were not aware of the American Heart Association recommendation that health professionals should be retrained every six months.[1] The reason for this recommendation is because of the rapid degradation of the skill that occurs after the initial training period. The six-month period has been determined by federally-funded multisite clinical trials of hypertension care and control.[14] Limitations to this study include the need for a larger sample size over a longer period of time, as well as the psychometrics being unknown. A more accurate estimation of student knowledge of blood pressure measurement assessment clearly would be direct observation of them assessing blood pressure. Further research is needed for a more accurate conclusions.

CONCLUSION

Our study has found the knowledge of blood pressure skills of a sample of chiropractic students to be deficient. However, similar deficiencies have been noted in medical, nursing, and pharmacy students. There is a need for improved knowledge in assessing blood pressure mea-

Table 7 - Factors Affecting the Accuracy of Blood Pressure Measurement and Percentage of Students of Each Profession That Scored a 70% or Higher[9,18]

Area	Chiropractic, $n = 186$	Medical, $n = 175$	Nursing, $n = 58$	Pharmacy, $n = 95$
n of BP measurements to be taken at each time it is measured	74	71.4	22.4	N/A
BP should be measured in both arms at the initial visit	81	38.9	74.1	N/A
Common causes of errors resulting in a higher BP measurement	31	60.3	75.5	53.8
Rounding off of the systolic reading to the nearest 2 mm reading	10	4.6	12.1	N/A
Rate of cuff deflation	88	42.3	79.3	46.1
Selection of correct cuff size	54	9.7	32.8	N/A
In the absence of a hard surface, the patient should hold the arm up	78	88.6	84.5	N/A
Know how to avoid the auscultatory gap	56	31.5	74.2	14.3

surement. We recommend that blood pressure measurement be taught in the 1st year and retraining should occur every six months, as recommended by the American Heart Association.[1] In addition, the use of a standardized checklist[11] would facilitate consistency among the trainers and observers of the skill.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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