Auscultatory Blood Pressure Measurement—Effect of Pressure on the Head of the Stethoscope

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Excessive pressure on the stethoscope head in auscultatory blood pressure measurement does not affect systolic blood pressure value but it does erroneously lower diastolic readings and frequently causes the sounds to persist to zero. Consequently, the lightest possible pressure should be placed on the stethoscope head.

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Current efforts relating to blood pressure have concentrated mainly on preventing, diagnosing and treating hypertension. Although it is appreciated that auscultatory measurements are not scientifically precise, observers have generally been content to accept these measurements as long as careful attention is given to controllable variables. One variable, the effect of pressure exerted by the examiner on the head of the stethoscope, has received only casual mention in the literature.[1-3] Although many clinicians are aware of this, it is our impression that it is generally disregarded. Furthermore, its effect on readings has never been documented.

We establish that pressure on the head of the stethoscope is not only a variable but is one of more than trivial importance. Our study consisted of two parts: one in which the effect of what was subjectively considered to be slight versus firm stethoscope pressure was examined and another in which the effect of pressure, quantified in millimeters of mercury and at levels unknown to the auscultator, was considered.

Subjects and Methods

Part 1

For the first part, 100 healthy adolescents, 14 to 18 years of age, were studied at the Central Juvenile Hall of the Los Angeles Probation Department. A mercury manometer, adult-size cuff and the bell end of a Littmann stethoscope were used. All measurements were made in the right arm with the subjects in the supine position. Readings were done initially in half of the boys with slight pressure on the stethoscope head, followed by a measurement with firm pressure. In the other half, the order was reversed, with the first reading obtained using firm pressure. Korotkoff phase V (cessation of sounds) was used for the diastolic signal. All measurements were made by one of us (S.L.).

Part 2

The subjects in part 2, 30 in number, were personnel and staff members of the UCLA Pediatric Department. There were 12 men and 18 women and their ages ranged from 25 to 50 years.

The observer who measured the pressures in part 1 took the readings in this part also. To eliminate any possible observer bias, measurements were made without his knowledge of how much pressure was being applied to the stethoscope head.

Two observers participated in this part of the investigation, and two mercury sphygmomanometers were used. One sphygmomanometer was connected to an adult-size cuff for the blood pressure readings, and the other was connected to a 9-cm cuff wrapped around the forearm over the stethoscope head, which was placed over the brachial artery area in the cubital fossa. The second cuff allowed varying amounts of measured pressure to be applied to the head of the stethoscope.

Measurements were made in the seated position with the arm at about heart level. Again, the bell side of the stethoscope was used. The investigator who made the

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measurements in part 1 did the listening, and a second investigator manipulated pressures in the two cuffs and recorded the readings.

Initially, a control blood pressure value was determined in the conventional manner with minimal pressure exerted on the stethoscope. The auscultator (S.L.) sat behind a screen shielding him from the subjects, the manometers and the other investigator. He was alerted each time the cuff was being inflated, and he signaled vocally when the vascular sounds appeared and disappeared.

Measurements were made with pressures of 10, 50 and 100 mm of mercury applied to the stethoscope. The sequence of these different degrees of stethoscope pressure was randomized so that the listener was at no time aware of the pressure applied to the stethoscope.

Statistical significance of values was based on the Student's *t* test.*

Results

Part 1

With light pressure on the stethoscope initially, the mean systolic pressures were 119±14.9 mm of mercury and 117±15.6 mm of mercury, respectively (± standard deviation). With initial firm pressure, the mean systolic pressures were 120±11.9 mm of mercury and 119±11.1 mm of mercury, respectively. These differences were not significant. However, there was a definite effect on the *diastolic* pressure values. Sounds persisted to zero in 42 of the 100 subjects with firm pressure but in only one with light pressure. The zero readings were excluded from the statistical analyses. Analysis of the remaining values showed, with initial light pressure, that the mean diastolic pressure was 2 mm of mercury lower with firm pressure, an insignificant difference. With initial firm pressure, however, the mean diastolic pressure was 8 mm of mercury lower with firm pressure, and this was significant ($P<.02$) (Table 1).

Part 2

The findings in part 1 were duplicated in the second part of the investigation. There was no significant effect on systolic blood pressure measurements even when as much as 100 mm of mercury pressure was applied to the stethoscope. The mean control systolic value was 115±10 mm of mercury; the mean values with 10 mm of mercury pressure on the stethoscope were 114±12 mm of mercury; with 50 mm of mercury stethoscope pressure, 115±12.2 mm of mercury, and with 100 mm of mercury stethoscope pressure, 115±12.5 mm of mercury.

*M. Ray Mickey, PhD, Department of Biomathematics, UCLA, did statistical analysis of the data.

TABLE 2.—*Effect on Mean Diastolic Blood Pressure Measurement of Different Measured Pressures on Stethoscope*

Number of Readings	*Diastolic Pressure mmHg±SD*	*Significance*
30 control	77± 9.3	
30 at 10 mmHg pressure	68±10.4	$P<.0001$
28 at 50 mmHg pressure*	62±18.7	$P<.0001$
30 at 100 mmHg pressure†		

SD=standard deviation

*Minus 2 zero readings.
†Only 7 of the 30 did not persist to zero, so statistical analysis was not possible.

All three levels of stethoscope pressure caused significant lowering of diastolic values. The readings were as follows: mean control pressure, 77±9.3 mm of mercury; 68±10.4 mm of mercury with 10 mm of mercury stethoscope pressure, and 62±18.7 mm of mercury with 50 mm of mercury stethoscope pressure. Vascular sounds persisted to zero in two subjects with 50 mm of mercury stethoscope pressure and in 23 with 100 mm of mercury stethoscope pressure, leaving too small a sample in the latter for comparison (Table 2).

Discussion

Only phase V was used for the diastolic signal because there is much greater certainty about the recognition of the cessation of sounds. In fact, the American Heart Association recently recommended the use of this signal for adults because "frequently the average observer has more difficulty in recognizing the muffling occurring during the fourth phase than recognizing the disappearance of sounds."[3]

"Firm" pressure (as much as 100 mm of mercury of measured pressure on the stethoscope head) obviously did not compress the brachial artery enough to prevent its opening and thus affect the systolic reading.

However, both "firm" pressure and as little as 10 mm of mercury of stethoscope pressure significantly lowered the diastolic readings. Furthermore, with "firm" pressure the sounds persisted to zero in 42% of the determinations. Similarly, with 100 mm of mercury stethoscope pressure this occurred in 77%. Even when sounds did not persist to zero, significantly lower

TABLE 1.—*The Effect of Firm Stethoscope Pressure on Mean Diastolic Blood Pressure Measurement*

	Number of Readings	*Light Pressure mmHg±SD*	*Number of Readings*	*Firm Pressure mmHg±SD*	*Significance*
Light pressure first	50	57±11.5	32*	55±15.8	NS
Firm pressure first	49*	60± 9.9	26*	52±16.6	$P<.02$

SD=standard deviation, NS=not significant

*Zero readings excluded.

diastolic values were observed both with firm and with measured pressure on the stethoscope.

The fact that this study was done on persons aged 14 to 50 years raises the question of whether the findings can be related to older people, many of whom have arteriosclerosis and hypertension.

It is common knowledge that in certain clinical conditions such as aortic insufficiency, hyperthyroidism and anemia, the vascular sounds may persist to zero.[4] These abnormal states produce in common a high pulse pressure. A high pulse pressure may also be related to persistence of vascular sounds in some persons who apparently have no abnormalities. Our findings suggest, however, that a more common cause is excessive pressure on the head of the stethoscope. The pressure should be so light that no skin indentations remain.

The precise mechanism responsible for the production of vascular sounds has not been firmly established, but according to Lange and Hecht,[5] they can be produced purely from disturbed flow without vibration of any physical structure. It is surprising that undue pressure on a stethoscope head has received such sparse mention in the literature because it may well constrict the brachial artery and cause turbulent flow.

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