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Accuracy of indirect blood pressure measurement in the elderly

A report of large discrepancies between direct and indirect measurements of blood pressure with increasing age¹ led to use of the term pseudohypertension in the elderly and speculation that indirect measurement is inaccurate in the elderly.² We assessed the effect of age on the accuracy of indirect measurements of blood pressure by comparing simultaneous direct and indirect measurements in elderly and young patients with high blood pressure. The ethical justification for performing direct intra-arterial measurement of blood pressure in the elderly patients was based on the fact that if the results of Spence *et al*¹ were valid direct measurement was indicated to determine the true blood pressure; if we established that pseudohypertension was not a true clinical entity, however, unnecessary direct measurement in the elderly would be avoided in future.

Patients, methods, and results

Forty elderly patients aged 60-80 (mean 68) and 20 young patients aged 24-43 (mean 38) were entered into the study consecutively from the clinic. All gave informed consent. The protocol was approved by the hospital ethics committee.

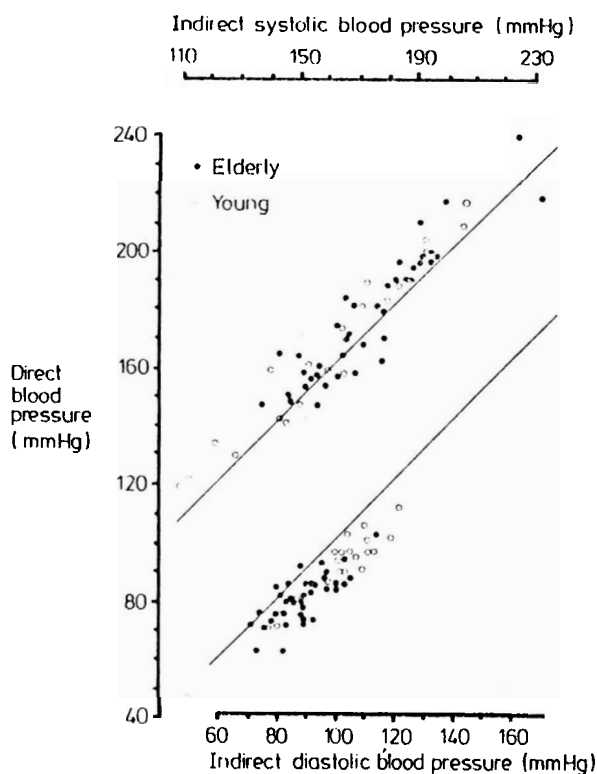
With the patient supine, indirect systolic and diastolic (phase V) blood pressures were recorded simultaneously in both arms with a standard mercury sphygmomanometer and cuffs with bladder dimensions of 22.5 × 12.5 cm. The cuffs were interconnected so that cuff pressures were identical in both arms. There was no significant difference in left arm circumferences between the groups. Direct blood pressure was measured with a 20 gauge Teflon cannula inserted into the radial artery and attached by a saline filled manometer line to a pressure transducer connected to an amplifier oscilloscope and strip recorder. Great care was taken with calibration, and the frequency response of the entire system was flat to 15 Hz. Direct intra-arterial recordings were compared with simultaneous indirect recordings made on the opposite arm, an event marker indicating on the strip recorder the first and last Korotkoff sounds. Indirect recordings were corrected for the difference between arms. Student's *t* test was used for comparison within groups (paired) and between groups (unpaired). The relation between direct and indirect pressures was compared between the two groups by covariance analysis.

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The figure shows the relation between direct and indirect pressures in both age groups. Indirect pressure underestimated direct systolic pressure by 4.4 ± 1.3 mm Hg in the elderly ($p < 0.005$) and 7.0 ± 1.6 mm Hg in the young ($p < 0.001$) and overestimated direct diastolic pressure by 9.2 ± 1.0 mm Hg ($p < 0.001$) and 10.4 ± 1.1 mm Hg ($p < 0.001$) respectively. These differences between techniques were not significantly different in the two age groups.



Relation between direct and indirect measurements of blood pressure in elderly and young patients. Unbroken lines are lines of identity.

The correlation between direct and indirect systolic blood pressure was significant in both groups (elderly: $r = 0.92$, $p < 0.001$; young: $r = 0.97$, $p < 0.001$). There was a similar positive correlation for diastolic pressure (elderly: $r = 0.76$, $p < 0.001$; young: $r = 0.93$, $p < 0.001$). Covariance analysis showed no difference between age groups in the agreement between direct and indirect pressures or in the slopes of the regression lines, which did not differ from unity.

Comment

The criteria for therapeutic intervention are ill defined in elderly patients with hypertension.² The report¹ of inaccuracies in the standard method of measuring blood pressure in the elderly added to this problem. There were, however, potential sources of error in this study: the patients were suspected of having large differences between direct and indirect pressures, the frequency response characteristics of the recording system were not stated, blood pressure recordings were not simultaneous, and, finally, the dimensions of the inflatable bladder used to measure indirect pressure (10 × 14 cm) might give a falsely high pressure.⁴ Indeed, when a larger cuff was used the differences between direct and indirect measurements in the elderly were greatly reduced. These sources of error were excluded from our study, and we could not find any significant difference in the relations between indirect and direct pressures in the young and old. There were, however, discrepancies between direct and indirect measurements in both age groups, which cannot be explained by the level of blood pressure or arm circumference. Three of the young patients and seven of the elderly patients had differences in systolic pressure of 14 mm Hg or more, and similar differences were observed for diastolic pressures in five of the young and 11 of the elderly patients.

This study shows that the standard technique of measuring blood pressure with a mercury sphygmomanometer is as accurate in the elderly as it is in young patients, and the indications for direct intra-arterial measurement are no different in the elderly than in other age groups.

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¹ Spence JD, Sibbold WJ, Cape RD. Pseudohypertension in the elderly. *Clin Sci Mol Med* 1978;55, suppl 4:399-402.

² Anonymous. Hypertension in the over-60s. [Editorial]. *Lancet* 1980;i:1396.

³ O'Malley K, O'Brien E. Management of hypertension in the elderly. *N Engl J Med* 1980;302:1397-401.

⁴ King GE. Taking the blood pressure. *JAMA* 1969;209:1902-4.

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