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Assessment of the accuracy and role of self-recorded blood pressures in the management of hypertension

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Abstract

Self-recording of the blood pressure by patients away from hospital or office ("home blood pressure") has been advocated as providing a better estimate of "true" blood pressure. The reliability of home blood-pressure recording has been assessed only by standard indirect methods which themselves are subject to considerable error and variability. The accuracy of self-recorded blood pressures was therefore assessed in 57 patients with essential hypertension by comparison with simultaneous measurements of clinic blood pressures and with intra-arterial blood pressures recorded at home and at hospital. Home systolic blood pressures showed good agreement with clinic and intra-arterial pressures, but home diastolic blood pressures overestimated intra-arterial pressures, as did clinic diastolic pressures. The clinic and home diastolic pressures showed good agreement. There was considerable variability in individual differences comparing the indirect and intra-arterial methods, though the two indirect methods showed much closer agreement.

This study suggests that home blood pressures are as accurate as clinic readings but may be recorded more frequently and thus provide more useful information. Neither is likely to approximate the intra-arterial blood pressure.

Introduction

Many workers have found a wide range of differences comparing intra-arterial blood pressure with indirect cuff measurements.¹⁻³ Indirect blood pressures are subject to considerable variability,^{4,5} and in order to minimise this variability serial measurements have been advised. The use of indirect methods by patients in their home surroundings permits serial blood-pressure measurements free of the tension associated with clinic visits.^{6,7} The accuracy of patient-recorded blood pressure, however, has not been thoroughly assessed.^{6,7}

We have attempted to assess the accuracy of patient-recorded measurements using the technique of intra-arterial ambulatory blood-pressure monitoring; in addition, we have compared home blood pressures, clinic blood pressures, and intra-arterial blood pressures—all recorded under standard conditions—in order to measure the relative accuracy of the indirect techniques against the standard of direct measurements.

Patients and methods

We recruited 57 patients from the hypertension clinic; 35 were receiving no medication. The group comprised 19 women and 38 men with a mean age of 52 years (range 23-70 years). The patients attended a special session of the clinic, where an indirect measurement was recorded using the Hawksley random-zero sphygmomanometer (Gelman Ltd). The patients were taught the technique of home blood-pressure measurements using a previously calibrated aneroid gauge and standard techniques⁸ of measurement, but using Korotkoff phase V for diastolic pressure. Only two patients found difficulty in mastering the technique and did not participate further; the remainder spent an average of 30 minutes in tuition. Each patient's technique of recording was checked using a double-listening stethoscope, but none of our patients was excluded from the study on the grounds of inaccurate recordings.

Home blood pressures were then recorded four times daily at set times for 10 days except on one day when the pressures were recorded hourly. During the 10 days intra-arterial ambulatory blood-pressure monitoring was performed over 48 hours using a technique which has been fully described.^{9,10} The physical characteristics and reliability of this system have been fully documented.¹⁰ During intra-arterial monitoring the patients attended the hospital at 12-hourly intervals

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Fig 1

Fig 2

Fig 3

Fig 4

FIG 1—Scatter plot and frequency histogram of home blood pressure—intra-arterial blood pressure (1 minute mean). Line shown in scatter plot is line of identity. Frequency histogram: systolic blood pressure—47% within ± 10 mm Hg, diastolic blood pressure—55% within ± 10 mm Hg (that is, 47% of systolic home blood pressures were within 10 mm Hg of intra-arterial pressure).

FIG 2—Scatter plot of clinic blood pressure—intra-arterial blood pressure (1 minute mean). Frequency histogram: systolic blood pressure—36% within ± 10 mm Hg, 67% within -20 to $+10$ mm Hg; diastolic blood pressure—65% within ± 10 mm Hg.

FIG 3—Trend plot of hourly mean intra-arterial blood pressure (●) compared with hourly home-recorded blood pressure (○) (.... $p < 0.05$; --- $p < 0.01$; — $p < 0.001$).

FIG 4—Scatter plot and frequency histogram of patient-recorded blood pressure—clinic blood pressure (laboratory data). Frequency histogram: systolic blood pressure—93% within ± 10 mm Hg; diastolic blood pressure—83% within ± 10 mm Hg.

during simultaneous auscultation. This is open to the criticism that there may be an interaction between the patient and observer over recognising the Korotkoff sounds which might lead to biased results. In addition, trained observers may vary considerably when recording the blood pressure,^{14 15} and the same observer may vary when reading the same pressure from a test film. For these reasons we considered it necessary to make comparison with direct measurements, which are not subject to the same variability as indirect methods. The use of intra-arterial ambulatory monitoring also allowed a check on the accuracy of home-recorded pressures which were measured away from the presence of a physician. In this study no patients were excluded and only two patients were unable to learn and apply the technique.

The validity of using a one-minute mean pressure from the intra-arterial record as a standard was checked by comparing this mean with a single random systolic and diastolic beat recorded during the same minute. The results (table I) showed that there was no significant difference.

The most important finding in this study was the wide scatter

of data when comparing simultaneous indirect and intra-arterial blood pressures (figs 1 and 2), differences of up to 50 mm Hg being recorded. While occasional large individual differences were obtained, the trend plots (fig 3) of hourly means compared favourably, suggesting that for a group of patients a reasonable estimate of blood-pressure patterns can be obtained by home-recorded pressures. There was only a slight difference between the variability of patient-recorded and clinic blood pressures in relation to intra-arterial pressures. Blood pressures recorded in hospital showed better agreement with intra-arterial blood pressures than did those recorded at home (tables I and II). The clinic pressure recorded with the random-zero sphygmomanometer was systematically lower than simultaneous intra-arterial pressures (mean 13/1 mm Hg) (table I). It may be concluded that the indirect methods gave only a rough estimate of the intra-arterial blood pressure and that there was little to choose between clinic-recorded or home-recorded pressures for accuracy. Home-recorded pressures, however, provided more readings throughout the day, and this information might have a clinical value of its own.

As mentioned above, simultaneous recordings of the blood pressure by a physician and patient may lead to biased results, and our data confirmed that this may happen (fig 4, table I). The mean difference of this patient-clinic comparison was -2 (SD 5.0)/2 (SD 7.0) mm Hg.

Similar discrepancies were reported by Joossens *et al*,¹⁶ who found a mean "patient-clinic" difference of 0.19 (SD 3.7)/4 (SD 3.5) mm Hg. Julius *et al*⁷ reported a mean "patient-clinic" difference of $-3/7$ mm Hg, while Laughlin *et al*¹³ reported a difference of $-11/-5$ mm Hg. The differences between the above comparisons probably result from the variability of the indirect methods.

Home blood pressures and indirect clinic measurements appeared to show good agreement, but neither indirect method accurately reflected the intra-arterial blood pressure. Home blood-pressure measurements are therefore subject to the same constraints as clinic measurements. Intra-arterial ambulatory monitoring remains the most accurate and well-defined method, but has a specific application as a research technique and cannot replace the indirect method of blood-pressure measurement. Home blood-pressure recording as an alternative may have a role in characterising populations and defining the efficacy of antihypertensive agents, but its limitations as a technique must be taken into account before conclusions can be drawn from the results.

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The GREAT ROUND-LEAVED DOLK, OR BASTARD RHUBARB has divers large, round thin yellowish green leaves rising from the root, a little waved about the edges, every one standing upon a reasonably thick and long brownish footstalk, from among which rises up a pretty big stalk, about two feet high, with some such high leaves growing thereon, but smaller; at the top whereof stand in a long spike many small brownish flowers, which turn into a hard three square shining brown seed, like the garden Patience before described. The root grows greater than that, with many branches or great fibres thereat, yellow on the outside, and somewhat pale; yellow within, with some discoloured veins like to the Rhubarb which is first described, but much less than it, especially when it is dry.

These also grow in gardens, and flower and seed at or near the same time that our true Rhubarb doth, viz they flower in June, and the seed is ripe in July.

Mars claims predominancy over all these wholesome herbs: You cry out upon him for an unfortunate, when God created him for your good (only he is angry with fools). What dishonour is this, not to Mars, but to God himself. A dram of the dried root of Monk's Rhubarb, with a scruple of Ginger made into powder, and taken fasting in a draught or mess of warm broth, purges choler and phlegm downwards very gently and safely without danger. The seed thereof contrary doth bind the belly, and helps to stay any sort of lasks or bloody-flux. The distilled water thereof is very profitably used to heal scabs; also foul ulcerous sores, and to allay the inflammation of them; the juice of the leaves or roots or the decoction of them in vinegar, is used as the most effectual remedy to heal scabs and running sores.

The Bastard Rhubarb hath all the properties of the Monk's Rhubarb, but more effectual for both inward and outward diseases. The decoction thereof without vinegar dropped into the ears, takes away the pains; gargled in the mouth, takes away the tooth ache; and being drank, heals the jaundice. The seed thereof taken, eases the gnawing and griping pains of the stomach, and takes away the loathing thereof unto meat. The root thereof helps the ruggedness of the nails, and being boiled in wine helps the swelling of the throat, commonly

called the king's evil, as also the swellings of the kernels of the ears. It helps them that are troubled with the stone, provokes urine, and helps the dimness of the sight. The roots of this Bastard Rhubarb are used in opening and purging diet-drinks, with other things, to open the liver, and to cleanse and cool the blood.

The properties of that which is called the English Rhubarb are the same with the former, but much more effectual, and hath all the properties of the true Italian Rhubarbs, except the force in purging, wherein it is but of half the strength thereof, and therefore a double quantity must be used: it likewise hath not that bitterness and astringency; in other things it works almost in an equal quantity, which are these: It purges the body of choler and phlegm, being either taken of itself, made into powder, and drank in a draught of white wine, or steeped therein all night, and taken fasting, or put among other purges, as shall be thought convenient, cleansing the stomach, liver and blood, opening obstructions, and helping those griefs that come thereof, as the jaundice, dropsy, swelling of the spleen, tertian and daily agues, and pricking pains of the sides; and also stays spitting of blood. The powder taken with cassia dissolved, and washed Venice turpentine, cleanses the reins and strengthens them afterwards, and is very effectual to stay the gonorrhoea. It is also given for the pains and swellings in the head, for those that are troubled with melancholy and helps the sciatica, gout, and the cramp. The powder of the Rhubarb taken with a little mumia and mander roots in some red wine, dissolves clotted blood in the body, happening by any fall or bruise, and helps burstings and broken parts, as well inward as outward. The oil likewise wherein it hath been boiled, works the like effects being anointed. It is used to heal those ulcers that happen in the eyes or eyelids, being steeped and strained; as also to assuage the swellings and inflammations; and applied with honey, boiled in wine, it takes away all blue spots or marks that happen therein. Whey or white wine are the best liquors to steep it in, and thereby it works more effectual in opening obstructions, and purging the stomach and liver. Many do use a little Indian Spikenard as the best corrector thereof. (Nicholas Culpeper (1616-54) *The Complete Herbal*, 1850.)