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COMMENTARY

Blood pressure measurement: the problem and its solution

T Marshall[1,2]
[1]Department of Public Health & Epidemiology, University of Birmingham, Edgbaston, Birmingham, UK;
[2]Division of General Medicine & Primary Care, Brigham & Women's Hospital, Boston, MA, USA

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In order to solve a problem, we need to realise that it exists, we need to appreciate its importance and we need a solution. This is only too evident to clinicians treating a symptomless risk factor like hypertension. The patient is generally unaware that there is a problem. Simply recognising that our patient has high blood pressure is not sufficient. We need him to understand that his high blood pressure has real consequences for his future health. Only then will he consider taking treatment.

Ironically, we are just beginning to appreciate the extent to which the measurement of blood pressure may itself be a problem. Matthys *et al*[1] are the latest in a series of investigators to demonstrate and quantify some of the many factors affecting blood pressure measurement in the clinic. They find that the presence of a final-year medical student raises measured blood pressure by 4.8/1.7 mmHg. Others have drawn attention to widespread use of uncalibrated sphygmomanometers,[2] zero-digit bias,[3] the effects of taking blood tests,[4] the influence of the rest period,[5] cuff size,[6] and a number of other factors on measured blood pressure.[7] Attention has been drawn to the misclassification that results from measuring something as intrinsically variable as blood pressure.[8]

So a problem exists, but is it important? Because the differences in measured blood pressure seem small, it is tempting to conclude that they do not really matter. This would be a mistake. There are three situations in which blood pressure measurement errors of this scale may be a problem.

The first situation is in the context of epidemiological studies. In the combined Health Surveys for England of 1998–2000, 37% of persons aged 35–74 years and 11% of those aged 25–34 years had blood pressure over 140/90 mmHg.[9] Had their blood pressure been measured in the presence of a medical student, the figures would have been 45 and 19%. These are important differences in prevalence; were they observed in successive surveys they would be taken to indicate an alarming rise in hypertension. In epidemiological studies, therefore the use of highly standardised methods of blood pressure measurement is critical.

The second situation is in the diagnosis of hypertension. Current guidelines emphasise the importance of cardiovascular risk calculation in the diagnosis of hypertension and recommend treatment of blood pressure over 140/90 mmHg only if 10-year cardiovascular risk exceeds 20%.[10] Cardiovascular risk is calculated from many variables, of which blood pressure is only one. Because of this, it is a more stable measure than blood pressure. The presence of a student would result in little overdiagnosis of hypertension among patients aged 35–74 years. However, because treatment is still recommended for all persons whose blood pressure exceeds 160/100 mmHg irrespective of their calculated cardiovascular risk, the presence of a student would double the rate of diagnosis of hypertension in people aged under 35 years.

The third situation is in the follow-up of hypertension. Here, the effect of measurement error is to play havoc with attempts to determine whether a treatment is effective. The average effect on blood pressure of a single antihypertensive drug at a standard dose is 9.1/5.5 mmHg.[11] This reduction may seem small in comparison to clinical experience. But in clinical trials blood pressure falls on placebo treatments, reminding us that much of the apparent fall in blood pressure seen in clinical practice is regression to the mean. In other words, the average blood pressure was overestimated before treatment. The important point is that the presence of a student has on average half the effect of a drug. This means that the presence or absence of a student during follow-up may significantly increase or decrease a drug's apparent effectiveness. This may result in unnecessary changes to medication. To add to the difficulty, it is well documented that day-to-day, within-individual blood pressure variability is

Correspondence: Dr T Marshall, Department of Public Health & Epidemiology, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK.
E-mail: T.P.Marshall@bham.ac.uk
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large. The coefficient of variation is at least 8% and may be very much higher.[12–14] This means that a single systolic blood pressure measurement of 140 mmHg has a standard deviation of at least 11 mmHg: larger than the effect of treatment. Indeed, it would be more accurate to cite a systolic blood pressure of 140 mmHg with its 95% confidence interval: 118–162 mmHg. Clinical guidelines are unhelpful on the follow-up of hypertension. All the main guidelines suggest that patients should be followed up and that clinicians should attempt to reach a target blood pressure. However, none offers advice on how many measurements clinicians should take before deciding whether to alter a treatment.[10,15,16] Clearly, insufficient attention has been paid to this problem.

The greatest difficulties caused by factors affecting blood pressure measurement in the clinic occur during patient follow-up. It is very difficult to tell whether fluctuations from day to day are the result of changes in the measurement technique, biological variations or treatment effects. There are two potential solutions to this problem. One solution is to abandon blood pressure measurement during follow-up and instead to adopt the 'fire and forget' approach advocated by some in the management of hyperlipidaemia.[17] The rationale for this is simple. The results of large clinical trials indicate that on balance the treatment is effective in most individuals. A few random clinic measurements are as likely to mislead us as to be helpful in determining whether or not the treatment is effective in any individual patient. Patients can therefore be given a standard dose of one, two or three antihypertensive medications depending on their pre-treatment blood pressure. Treatment need only be altered if they experience adverse effects. However, the 'fire-and-forget' may not be a suitable strategy for a condition where some individuals respond well to one drug and less well to another.[18] Nor is this approach likely to be acceptable to clinicians.

The other solution is to take more frequent measurements during follow-up and to make decisions on the basis of many rather than few measurements. There are two ways of doing this: one is to use ambulatory blood pressure monitoring and the other is for patients to undertake home measurements. Of these two methods, home measurement by patients is the most practical. Studies have shown to produce results similar to that of ambulatory blood pressure monitoring.[19] It is acceptable to patients.[20] Most recently, the use of home measurements during follow-up has been shown to lead to lower costs and less intensive treatment when compared to clinic measurements.[21] There is even potential for the use of charting techniques to improve the sensitivity of home measurements as a means of determining treatment effects.[22,23] This is not to say that home measurement is problem free: not all sphygmomanometers are accurate;[24] some patients cannot undertake self-measurement. However, as Matthys *et al* demonstrate yet another problem with clinic-based measurements, perhaps it is time to start looking at the alternatives.

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