What to do when faced with an unmeasurable ambulatory blood pressure?

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If ambulatory blood pressure measurement is not possible because the upper-arm circumference is so great that even the largest cuff provided with the monitor will not encircle the arm, satisfactory measurements can be obtained by applying a cuff to the forearm. *J Hypertens* 29:451–453 © 2011 Wolters Kluwer Health | Lippincott Williams & Wilkins.

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Abbreviations: ABPM, ambulatory blood pressure measurement; BP, blood pressure

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The clinical problem

A 61-year-old woman was referred to me by her diabetologist for assessment of elevated blood pressure (BP). She had a history of diabetes mellitus, dyslipidaemia, obesity, hypertension and sleep apnoea for many years. The severity of her hypertension was questioned because her arm circumference was so large that conventional BP measurement was not possible even with an adult thigh cuff, which only barely encircled her arm. Quite apart from the length of the thigh cuff being inadequate, her upper arm was too short to accommodate a cuff with width of 16 cm. I was asked particularly to perform 24-h ambulatory blood pressure measurement (ABPM) so as to determine if in addition to having elevated BP, she might also have a nondipping nocturnal BP pattern that is common in diabetic patients and which carries a poor prognosis [1,2].

On examination she was very obese (BMI 49 kg/m^2; height 167 cm; weight 136 kg). I was unable to measure BP by auscultation with a mercury sphygmomanometer because her arm circumference was 53 cm and neither a large adult cuff (bladder dimensions 35 cm × 12 cm) nor an adult thigh cuff (bladder dimensions 42 cm × 16 cm) would encircle her arm. I was unable also to apply a Spacelabs ambulatory monitor (Spacelabs 90207; Spacelabs, Hertford, UK) using an extra large adult cuff (bladder dimensions 33 cm × 15 cm) as it did not encircle her arm.

So here was a patient sitting in front of an 'expert' (as she put it) who could not carry out what must have seemed to her to be a relatively simple request.

The clinical solution

Conventional blood pressure measurement

There are two options available for measuring BP in patients with very obese arms. First, BP can be measured on the forearm by placing a cuff on the forearm and auscultating the Korotkoff sounds over the radial artery. I did this by placing a cuff with a bladder measuring 33 cm × 12 cm on her forearm, the circumference of which was 31 cm, and I auscultated the Korotkoff sounds over the radial artery recording a BP of 132/60 mmHg. Measurement of BP by auscultation over the radial artery was first described in 1956 [3] and the procedure is recommended for patients with very large arm circumferences [4]. The second option is to apply a wrist-measuring device. Wrist-measuring devices have been shown to be accurate (see www.dableducational.org) but are not recommended for self-measurement of BP because of concern that the arm will not be kept at heart level during use with the consequent likelihood of erroneous readings [5,6]. However, the validated devices can give accurate BP measurement under supervision and are recommended for patients with large upper arms [5]. Most wrist devices provide cuffs for wrist circumferences up to a maximum of 21 cm, whereas my patient's wrist circumference was 27 cm and I did not pursue this option. Manufacturers of wrist devices should give consideration to supplying cuffs to encircle large wrists.

Ambulatory blood pressure measurement

There are no recommendations as to how ABPM should be performed in patients with very obese arms. The only option presently available is to use forearm measurement. I applied an adult Spacelabs cuff with a bladder measuring 23 cm × 12 cm to the right forearm, and the patient found it more convenient to put the Spacelabs 90207 recorder in her trouser pocket rather than on a belt. Manual BP measurements with the Spacelabs monitor in my office were 128/42 and 131/57 mmHg. I set the monitor to measure BP every 30 min during the day and night. I instructed her to take particular care to ensure that her arm was supported at heart level (preferably on a

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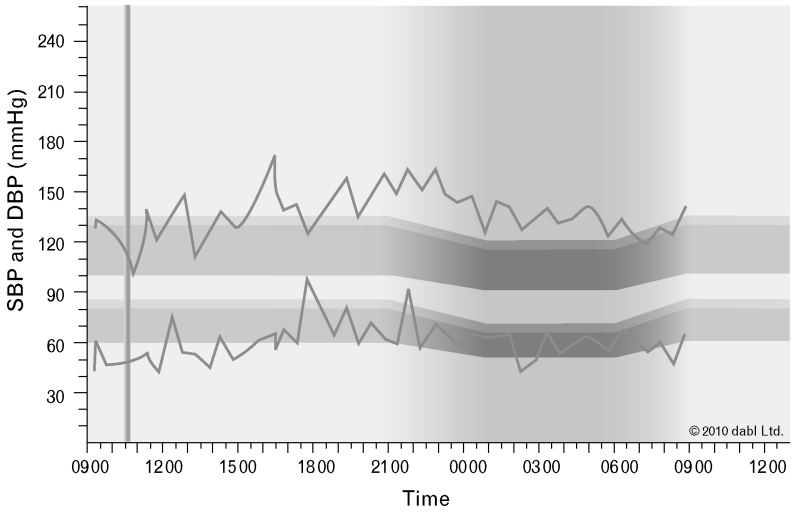
Fig. 1



White-coat window	SBP	DBP	HR
Readings	4	4	4
First hr max	131	57	84
Load	0	0	0
Day time (09:00–21:00)			
Readings	22	22	22
Mean	**136**	**61**	59
SD	15	12	9
Load	30	4	0
Night-time (01:00–06:00)			
Readings	10	10	10
Mean	**135**	**57**	54
SD	6	7	3
Load	50	0	0
24-h			
Readings	46	46	46
Mean	**137**	**60**	56
SD	13	10	7
Load	41	3	0
Dip%	1	6	10

Forearm ambulatory blood pressure measurement.

table) during measurement. The day of recording was uneventful and the interpretative ABPM report (Fig. 1) indicated borderline daytime systolic hypertension (136 mmHg), normal daytime diastolic BP (61 mmHg) and mild night-time isolated systolic hypertension (135/57 mmHg).

How common is an unmeasurable blood pressure?

The risk of hypertension is up to five times higher among obese people than among those of normal weight [7]. Up to two-thirds of cases of hypertension are linked to excess weight [8], and cross-sectional population surveys suggest that more than 85% of hypertension arises in individuals with BMI values above 25 kg/m^2 [9]. In obese patients undercuffing by using a cuff with an inflatable bladder that is too short for the arm will cause overestimation of BP, so called 'cuff hypertension' [10]. In the USA, some 15 million men and 10 million women aged 40–59 years currently require the use of large-sized rather than standard adult-sized cuffs for accurate BP measurement. The need for large-sized cuffs is also rapidly growing in the 20–39-year-old age group [11].

How important is the problem?

If BP measurement is inaccurate it follows that all diagnostic, management and treatment decisions will be flawed. The International Obesity Task Force estimates that more than 300 million individuals worldwide are obese and an additional 800 million are overweight [12]. At least 1.1 billion adults and 10% of children are now overweight or obese [13]. The number of deaths per year attributable to obesity is about 30 000 in the UK and 10 times that in the USA, where obesity has overtaken smoking as the main preventable cause of illness and premature death [12]. With the growing epidemic of obesity, the need to measure BP in patients with large arm circumferences will increase. The increasing prevalence of obesity will, in turn, lead to doctors being faced with the problem of measuring BP in patients with very large arms. The occurrence of diabetes and the metabolic syndrome in obese patients, with the requirement for optimal blood pressure control in these patients, presents a very serious clinical challenge.

Future for forearm ambulatory blood pressure measurement

To my knowledge, this is the first report of forearm measurement to obtain 24-h ABPM recordings. Studies comparing forearm and upper-arm cuff occlusion for conventional BP measurement have given conflicting results [14–17], but it is likely that higher readings are obtained with forearm measurement [6].

The major precaution to be taken with forearm measurement is to ensure that the arm is kept at heart level but, as patients undergoing ABPM with upper arm measurement are advised to rest the arm on a table during measurement, current practice is not greatly altered by the changed procedure. Forearm ABPM appears to be a feasible option in patients with very large upper arms but there is now need for a well conducted study to compare forearm and upper-arm ABPM so that hypertensive patients with very large arms are not denied this important investigation. One aspect of such research would be to determine the accuracy of BP measurement with an ambulatory device on the upper arm compared to forearm measurement using the International Protocol of the European Society of Hypertension [18].

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