Assessing ambulatory blood pressure in renal diseases: facts and concerns

Empar Lurbe and Josep Redon

Paediatric Nephrology, Department of Paediatrics, General Hospital and Hypertension Clinic, Internal Medicine, Hospital Clinico, University of Valencia, Valencia, Spain

Office blood pressure (OBP) measurement has provided the basis for what is known about the potential risk associated with hypertension and has guided patient management for many years. The mercury sphygmomanometer was the standard method for BP measurement since early this century. In the last few years, however, a rapid increase in the use of automatic and semiautomatic devices for measuring BP has been observed in medical and non-medical environments. This was the consequence of awareness of the importance of BP values taken under regular living conditions. Additionally, the upcoming ban on the use of mercury in developed countries, already a practice in the Scandinavian countries and the Netherlands, has led to the almost inevitable conclusion that the Riva Rocci technique will disappear from clinical practice, and the mercury sphygmomanometer will be replaced by accurate, independently-validated automated devices.

The accuracy of novel devices—a cause for concern

The rapidly expanding number of new devices and the necessity of replacing the mercury sphygmomanometer, has raised concerns about the accuracy of BP
values measured by monitors. This is an important issue for nephrologists, because hypertension is prevalent in renal diseases, and lowering BP is one of the main strategies for reducing the declining rate of glomerular filtration and preventing or at least retarding the progression toward end-stage renal disease [1–3]. Having reliable BP measurements is, therefore, crucial to the management of renal diseases.

The present level of knowledge regarding the relationship between BP and renal disease has been reached using office BP measurements, data that have the potential for inaccuracy due to the white-coat effect. Recently, however, methods have been introduced which allow doctors to obtain BP measurements during a patient’s normal daily activities, those outside of a medical environment. One advantage of these ambulatory BP measurements over office BP, derives from the more precise estimation of BP values obtained through the average of a great number of measurements taken under ordinary living conditions outside of the medical environment [4,5]. Another advantage is the opportunity to obtain estimates of the BP circadian variability [6,7].

The importance of circadian blood pressure variability and night-time dipping

The importance of the circadian variability of BP as either a marker or a pathogenetic factor for kidney damage has been stressed in many studies. A blunted decline in the physiological BP nocturnal fall, the non-dipper pattern, has been observed frequently in patients with renal failure before or during renal replacement therapy: the lower the glomerular filtration rate, the lower the BP decline during the night [8]. The lowest BP reduction during sleep seems to be associated with the highest decline in glomerular filtration rate in patients with renal failure [9]. A non-dipper pattern is also common in diabetic nephropathy before the latter develops into renal failure [10]. Even in the absence of hypertension, a smaller decline in BP during the night has been observed in microalbuminuric diabetics, those patients prone to develop overt nephropathy [11]. Nonetheless, the relationship of nocturnal fall in BP with kidney damage is a matter of debate. Some evidence supports the potential role of systemic BP transmission as a mechanism of inducing renal damage, whereas other evidence supports the non-dipping pattern as a consequence of the renal damage itself. The interpretation of these data as being the cause or the consequence is not mutually exclusive. In some cases, higher BP values during night-time may contribute to the progression toward renal insufficiency, while in other cases, the values are but a consequence of the altered renal function itself. In the latter, higher BP may also participate in accelerating the loss of renal function, completing a vicious circle. Thus, the assessment of ambulatory BP may provide valuable information regarding the risk of renal damage.

Ambulatory monitoring versus home self measurement

There are two methods for measuring ambulatory BP: ambulatory BP monitoring (ABPM) using automatic monitors which permit a patient’s BP recordings to be taken during daily activities and during sleep, and manually operated or semiautomatic monitors for home BP self-measurement (BPSM). Both methods make it possible to carrying out a great number of measurements while outside a clinical situation, avoiding alert reaction during the BP measurement. They differ, however, in that ABPM permits the assessment of circadian variability and nocturnal BP, parameters not obtained through BPSM.

Up to now, the quantity of applicable knowledge regarding methodological aspects, reference values, prognostic and clinical value for ABPM has been much greater than that obtained through BPSM. Still, one of the limitations of ABPM is that repeated monitoring may be annoying to patients and, therefore, can only be performed from time to time. A second limitation is the relative cost of ABPM. Consequently, BPSM has been advocated as an alternative to ABPM.

The BP values obtained through either ABPM or BPSM have demonstrated a better reproducibility [12–14], have produced a better correlation with end-organ damage in hypertensive patients and have given a better prognosis for cardiovascular morbidity and mortality [15–17] than are those results obtained through office BP. Thus, ambulatory BP values become a better marker of cardiovascular and renal risk than its office BP counterparts.

Automatic monitoring and self-measurement provide close ambulatory BP values, given lower BP values than those measured in office settings [18]. The higher the BP the higher the differences between office and ambulatory BP values. Research has been moving to get enough information about what the BP threshold for starting antihypertensive treatment is, and has been assessing what the BP goal is during treatment [19]. During the last few years, a great amount of information for defining reference ambulatory BP values has been collected [20,21]. Reaching an optimal BP goal, however, presents many more difficulties.

Normal blood pressure values for ABPM and BPSM

Using ABPM, the normotensive state was defined as the average of awake BP lower than 130/80 mmHg, and hypertension as the average of awake BP equal or greater than 135/85 mmHg [22]. When BPSM was used, the reference values defined hypertension as the average of BP values equal to or greater than 135/85 mmHg [23].

As of now, no information is available regarding what the target ambulatory BP is during antihypertensive treatment. Data from a large group of patients
enrolled in the HOT study [24] indicate that office and ambulatory BP are comparable during long-term antihypertensive treatment. This fact may presuppose that the ambulatory BP goal for protecting kidney function will not differ from the BP goal defined by office BP. Obtaining BP values as low as possible, in the absence of symptoms of hypotension or coronary heart disease, should be the main objective. In patients with proteinuria higher than 1 g/24 h, it should be lowered to an average systolic BP/diastolic BP < 125/75 mmHg [2].

Assessing nocturnal BP as a target for protecting against kidney damage seems to be important in renal diseases treatment. The nocturnal BP goal to achieve needs to be defined from prospective studies.

Validation of the novel methodologies

Ambulatory BP is assessed using automatic or semi-automatic devices, with auscultatory or oscillometric methods. The methodology of BP measurement is recognized as being a cause for concern. If we are looking for the most accurate BP values, the characteristics and capacities of the monitors becomes a key point. The validation of new devices have been performed testing agreement among monitors and mercury sphygmomanometer. A small number of studies used as reference the Hawksley random-zero sphygmonanometer which is susceptible to unintentional misuse [25], but in this case the obtained grades for the tested monitor were lower than those obtained against mercury sphygmomanometer [26].

There are four validation protocols available [27–30]. The two most widely accepted are those released by the Association for the Advancement of Medical Instrumentation (AAMI) [27] and by the British Hypertension Society (BHS) [28]. The other two are locally used in Germany [29] and in Australia [30]. These protocols, which differ in detail, but have a common objective the standardization of validation to establish minimum standards of accuracy and performance and to facilitate comparison of one device with another.

The AAMI protocol qualifies a monitor as it passes or fails the established criteria (mean difference must be <5 mmHg and standard deviation <8 mmHg) [27,31], whereas the BHS grades the agreement between the monitor and the sphygmomanometer in four categories, from A the best to D the worst. To meet the BHS protocol, devices must achieve at least a grade of B/B [28,32]. Validated monitors are now available, and several groups of experts encourage the use of only those which pass the validation protocols.

Among the 43 ABPM devices marketed in 1995, 18 had been validated either using the AAMI or the BHS protocols. Nine of these had failed to adhere to the protocols thereby rendering the results questionable, and further nine devices fulfilled the requirements of both protocols [33]. In 1998, twenty-seven validation studies performed on 18 ambulatory systems were published, of which fourteen devices fulfilled the criteria for one or both protocols [34–36].

The validation studies published were performed mainly in adult populations, but a few provided validation in special populations, such as children [37,38], pregnant women [37,39–43] and the elderly [37,44]. The increasing use of ABPM in populations with special characteristics on arterial compliance and/or pulse pressure amplitude, requires a large number of validation studies which will allow us to better compile the BP information now available and define protocols for the proper use of ABPM in these populations.

Among the several hundreds of different monitors available for BPSM, only a small percentage have been validated, of which four were deemed satisfactory according to the criteria of the BHS and/or AAMI protocols [34].

The introduction of wrist devices deserves comment. During the last few years, monitors placed on the wrist providing accurate BP measurements when intra-arterial comparisons were used [45], were marketed and rapidly gained an important percentage of the market share in Germany and in other European countries. Despite the resulting good grades the validation studies offered, a comparison of the values obtained on the wrist with those obtained on the arm resulted in a great variability. Other concerns are that differences between arm and wrist BP are variable as a function of arterial stiffness, and that the wrist device placement seems to offer more difficulties than does that for arm cuffs.

Reliability in the reporting of BPSM values needs to be mentioned as a potential drawback. A recent study [46], compared automatic stored BP measurements with the respective logbook entries in a group of thirty well-trained hypertensives. The authors found a substantial observer error in the reporting of BPSM values. The percentage of reporting errors was close to that observed with reported home blood glucose levels in type I diabetics [47]. The impact of reporting errors needs to be considered when BPSM is contemplated.

Efforts are necessary for developing accurate automated monitors suitable for self-measurement, ABPM or office and hospital use. Developing new devices need to redefine the validation protocols [48]. The two protocols widely accepted, those proposed by the AAMI [31] and the BHS [32], are complex, lengthy and expensive to perform, raising the necessity for a cheap, less complex common protocol to be developed [34,48].

Conclusion

In summary, the management of patients with renal diseases may be improved by assessing ambulatory BP. Several monitors are now available which meet the
required criteria of the validation protocols. Accurate devices and easier validation protocols, however, should be developed due to the rapidly expanding use of devices for measuring BP outside the clinic, and the imminent retirement of the classic sphygmomanometer using mercury.

References

27. American National Standard for electronic or automated sphygmomanometers. Association for the Advancement of Medical Instrumentation, Arlington VA, 1993; 40