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Bulletin de la Dialyse à Domicile

Can blood pressure be measured without undressing patients?

(Peut-on mesurer la tension artérielle sans déshabiller les patients ?)

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Résumé

Pour mesurer la pression artérielle, les recommandations imposent de positionner le brassard sur un bras nu, sans manche relevée. Ces recommandations sont parfois difficiles à appliquer en clinique courante dans certaines circonstances, comme dans les centres de dialyse où la mesure est répétée chez des patients souvent âgés et fragiles. Dans cette étude, nous avons évalué la validité de la mesure de la tension artérielle avec brassard positionné sur un bras nu, comparé à un brassard positionné sur plusieurs couches de vêtements.

Au total, 1 224 mesures de tensions artérielles ont été réalisées chez 51 patients hémodialysés pendant une durée d'un mois, 6 mesures par semaine soit 24 mesures par patient. Les patients portaient leurs vêtements ordinaires adaptés à une saison d'hiver. Ainsi, 612 mesures ont été réalisées avec brassard sur bras nu, et 612 mesures avec brassard sur vêtements. La moyenne des tensions systoliques était respectivement de 121,9 et 123,5 mmHg lorsque le brassard était mis en place sur vêtements et sur peau nue. La moyenne de tension diastolique était respectivement de 60,1 et 60,5 mmHg. La différence observée n'atteint pas le niveau de significativité statistique avec respectivement p = 0,168 et p = 0,135. Il en est de même pour la pression artérielle moyenne, avec respectivement 80,6 et 81,5 mmHg (p = 0,142). La différence observée ne justifie pas le déshabillage des patients pour lesquels cette procédure est difficile, inconfortable ou douloureuse.

Mots clés : Pression artérielle, mesure de la pression artérielle, vêtements, tensiomètre, hémodialyse

Summary

The guidelines recommend that the technique of measuring arterial blood pressure requires positioning the cuff on a bare arm, without rolled-up sleeve. These recommendations are sometimes difficult to apply in routine practice, as in dialysis centers where the measurement is repeated in fragile patients. In this study, we assess the validity of the blood pressure measurement with a cuff positioned on a bare arm, compared to a cuff positioned on several layers of clothing.

A total of 1,224 blood pressure measurements were taken in 51 dialysis patients over a period of one month, 6 measurements per week, i.e. 24 measurements per patient. The patients wore their ordinary clothes suitable for a winter season. Thus, 612 measurements were taken with a cuff on a bare arm, and 612 measurements with a cuff on clothing. The mean systolic pressures were 121.9 and 123.5 mmHg, respectively when the cuff was placed on clothing and bare skin. The mean diastolic pressure was 60.1 and 60.5 mmHg, respectively. The observed difference does not reach the level of statistical significance with respectively p = 0.168 and p = 0.135. The same is true for mean arterial pressure, with 80.6 and 81.5 mmHg respectively (p = 0.142). The difference observed does not justify the undressing of patients for whom this procedure is difficult, uncomfortable or painful.

Key words : Blood pressure, blood pressure measurement, clothes, blood pressure monitor, hemodialysis

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INTRODUCTION

For more than 100 years, the gold standard for measuring blood pressure has been the use of the mercury sphygmomanometer and stethoscope. The blood pressure cuff has to be placed on bare skin. This method is based on auscultation. The appearance and disappearance of Korotkoff's sounds are closely and respectively related to systolic and diastolic arterial pressures. For more than 20 years, electronic blood pressure monitors have gradually been replacing manual blood pressure monitors. Electronic blood pressure monitors have become more reliable, more accurate and easier to use than sphygmomanometers. These new devices do not use the auscultatory method, but oscillometric techniques. Oscillometry does not actually measure blood pressure. It detects and analyzes pulse waves, transformed into arterial pressure by algorithms [1].

Different national and international recommendations specify the technical conditions for measuring blood pressure. Among these recommendations, several require the cuff to be placed on bare skin [2-8]. In addition, the patient must first be undressed, because the mere fact of raising the sleeve leads to a possible bias by "tourniquet effect" [1]. However, other recommendations do not impose the positioning of the cuff on bare skin, arguing that the standard recommendations do not apply to all electronic blood pressure monitors [9, 10]. Users are therefore invited to follow the device manufacturer's instructions. In general, the manufacturer's instructions include the following statement: «*Place the cuff directly on the skin. The presence of clothing can attenuate the detection of the pulse, and be the cause of measurement errors. Raising the sleeve can cause constriction, causing imprecise measurement.*»

In current clinical practice, there are circumstances in which it is difficult to apply the recommendations. For elderly, fragile, non-autonomous or disabled patients, undressing is often a long, delicate, and sometimes painful process, especially in the winter season. When the blood pressure measurement is repeated, it causes discomfort for the patient. In ambulatory hemodialysis centers, where blood pressure is measured several times during a hemodialysis session, strict adherence to protocols requires the patient to be undressed for several hours. In order not to add discomfort to a patient who is already undergoing heavy and restrictive treatment, professionals often deviate from the recommendations and measure blood pressure with a cuff on clothing, if not on a bare arm with the sleeve raised.

The objective of the present study was to evaluate the validity of the measurement of blood pressure with a cuff positioned on the clothing. The originality of this study is inherent in the population studied: elderly hemodialysis patients, most of them with numerous comorbidities. The reliability of the results was improved by repeating blood pressure measurements during hemodialysis sessions. The study was performed in an outpatient hemodialysis center under «real life» conditions. The study took place in winter, with patients wearing multiple layers of clothing constituting the ordinary clothing of a population in an area with an average outside temperature of 7 ° Celsius.

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MATERIAL AND METHODS

Population

The population included all dialysis patients in an outpatient hemodialysis center (CA-ECHO in Vannes - Morbihan, France). Patients who did not wish to undress for blood pressure measurement were not included in the study.

The study lasted for one month, from 02/01/2018 to 02/28/2018. During the period under review, the population of the center totaled 74 patients.

Study design and ethics

This was a descriptive, open, controlled, mono-centric study. It was a non-interventional study of routine care, and was outside the Jardé law, with total and irreversible anonymization of data. All patients had previously given their consent to use the data contained in their computerized records for medical research purposes, in accordance with the opinion of the establishment's Ethics Committee. Patients were informed about the use of their data for research and statistical purposes. The patients selected for the study all gave their consent.

Procedures

Blood pressure was measured when each patient arrived at the dialysis center, before their hemodialysis session. The patient was placed in the supine position and remained at rest for at least 10 minutes before the blood pressure measurement. Two measurements were taken at an interval of 5 minutes: one measurement with the cuff positioned on the bare arm, one measurement with the cuff positioned on the clothes. The chronology of these two measurements was random: either cuff on bare arm and then cuff on clothing, or cuff on clothing and then cuff on bare arm. When the blood pressure was measured on a clothed arm, it was carried out without the distinction of the number of layers of clothing or their thickness. The type of clothing was not detailed in the analysis, to remain under the conditions of ordinary «real life» blood pressure measurements. For each patient, this procedure was repeated at each dialysis for one month, for a total of 12 observations per patient, and 24 blood pressure measurements. The blood pressure monitor used was integrated into the hemodialysis machine.

These were oscillometric-type blood pressure monitors, comparable in design and operation to standard electronic blood pressure monitors.

Statistics

The statistical method used for the comparison of means was Student's t test on paired series. The covariance was specified by the Pearson correlation coefficient. The statistics were supplemented by a Bland-Altman test for the analysis of concordance. The statistics were analyzed by the XLSTAT software version 2021.1 in a Microsoft Excel database.

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RESULTS

A total of 1224 blood pressure measurements were performed in 51 patients. Patient characteristics are shown in Table 1.

Table I. Characteristics and comorbidities of the patients studied

	N (Total = 51)	%
Ratio M / F	31 / 20	61 / 39
Mean age M / F	73 yrs / 77 yrs	
Seniority in dialysis	32 +/- 16 mois	
Technique HD / HDF	54 / 16	75 / 25
Ratio AVF / KT	44 / 9	86 / 14
Presence of at least one comorbidity	45	88
Diabetes	14	27
Chronic respiratory failure	5	10
Cardiac failure	5	10
Coronary insufficiency	10	20
History of myocardial infarction	6	12
Cardiac arrythmia	19	37
Abdominal aortic aneurysm	2	4
Arteriopathy of the lower limbs	18	35
History of CVA	6	12
History TIA	2	4
Hemopathy	8	16
Hepatic cirrhosis	1	2

HD : Hemodialysis ; HDF : Hemodiafiltration ; AVF : Artério-veinous fistula ; KT : Central veinous catheter; CVA : history of cerebro-vascular accident; TIA : History of transient ischemic attacks

All the patients underwent dialysis at the rate of 3 weekly sessions, with an average duration of 234 +/- 16 minutes per session. For each patient, arterial blood pressure were measured at each dialysis session for 1 month. That is, there were 6 measurements per week, i.e 24 measurements per month. Of the 1,224 measurements recorded, 612 measurements were carried out with a cuff on a bare arm, and 612 measurements with a cuff on a dressed arm. The number of layers of clothing and their thickness corresponded to the ordinary dress of a population in winter in a temperate coastal region. The average outdoor temperature recorded in the region during the study period was 7 ° Celsius: 4 ° Celsius in the morning and 8 ° Celsius in the afternoon [11]. The patients wore clothes suitable for the corresponding weather conditions. The mean systolic blood pressures were 121.9 and 123.5 mmHg, respectively, when the cuff was placed on clothing and bare skin. The mean diastolic blood pressure was 60.1 and 60.5 mmHg, respectively. The observed difference did not reach the level of statistical significance, at $p = 0.168$ and $p = 0.135$, respectively. The same was true for mean arterial pressure, at 80.6 and 81.5 mmHg respectively ($p = 0.142$). The results are shown in Table 2.

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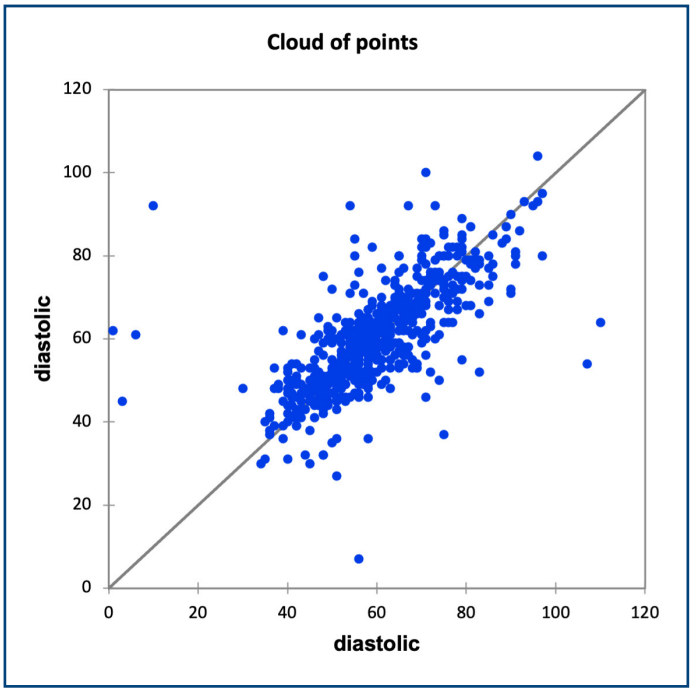
⬇ *Table II. Systolic, diastolic, mean, maximum and minimum arterial pressures measured in 51 patients for 1 month (24 measurements per patient)*

Mean arterial blood pressure (AP), Maximum and minimum (mmHg)	cuff on clothes N = 612	cuff on bare arm N = 612	t-Test
Systolic AP	121,94 ± 25,57	123,51 ± 25,28	p = 0,168
Diastolic AP	60,15 ±12,48	60,52 ± 12,23	p = 0,135
Mean AP	80,61 ± 12,48	81,51 ± 16,15	p = 0,142
Max systolic AP	219	227	-
Min systolic AP	58	75	-
Max diastolic AP	110	104	-
Min diaslolic AP	30	27	-

In theory, the presence of one or more layers of clothing between the cuff and the skin dampens the detection of the signal by the sensors. As with the auscultatory method, the damping of the pulse wave detected by oscillometry is more pronounced on diastolic blood pressure. The Bland-Altman test was applied to the diastolic arterial tensions in order to specify the concordance (Figs. 1 and 2).



⬆ *Figure 1. Bland-Altman analysis of diastolic blood pressure: Bias = 0,606. Standard error = 9,974. IC Bias (95 %) = [-0,19 ; +1,40] IC differences (95 %) = [-0,19 ; +20,16]*

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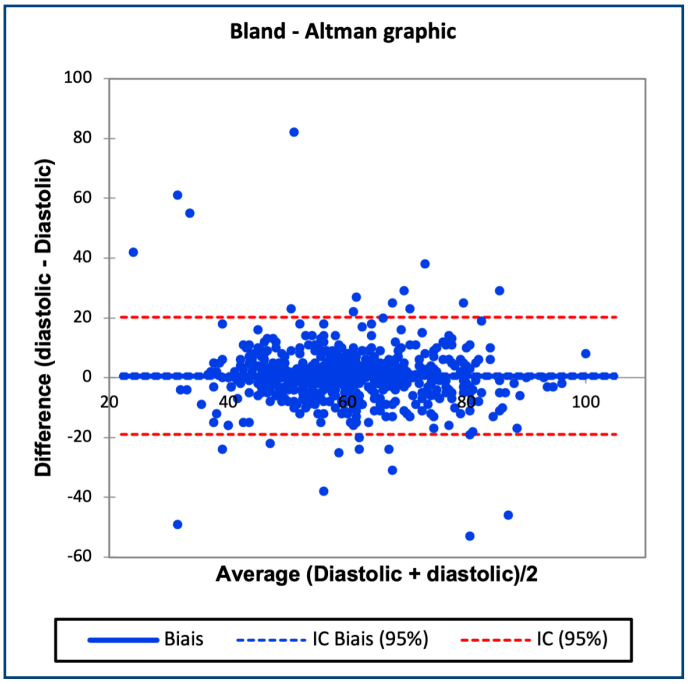

Figure 2. Bland-Altman graph of diastolic blood pressure.
Correlation coefficient (Pearson) = - 0,09. IC (95%) = [-0,17 ; -0,01]

The blood pressure results were consistent with a damping of the pulse wave when the cuff is positioned on the clothes, since the values measured in this case, for both systolic and diastolic pressure, were lower than those measured with the cuff positioned directly on the skin. The difference was not significant when analyzed by a binary test such as a null hypothesis test. However, Pearson's correlation suggested that there was a small difference.

DISCUSSION

In the present work, we investigated the impact of having layers of clothing under the cuff when measuring blood pressure using electronic blood pressure monitors. With a total of 1,224 measurements, this is the largest study to date on the subject. When the cuff is placed directly on the bare arm, the pulse wave detected by oscillometry is poorly damped. The theoretical bias of a measurement with a cuff on clothing is a damping of the pulse wave, resulting in an underestimation of blood pressure. The results observed in our study were consistent with these principles, since the average arterial blood pressure, whether systolic or diastolic, were lower when the cuff was positioned on clothing versus a bare arm. However, this difference was small and not very significant. The arterial blood pressure measured with a cuff on clothes and on a bare arm were 121.9 / 60.1 and 123.5 / 60.5, respectively (p = 0.142).

In a previous study, Kahan found similar results by comparing blood pressure measured in 201 healthy people, in three configurations: cuff on bare arm, on clothing, and bare arm with the sleeve raised [12]. The differences observed were small and not significant. In another study involving 376 patients, the differences observed were 4.1 mmHg for systolic and 0.1 mmHg for diastolic, which was not significant [13]. Clothing thickness has been described as having no impact on measurement [14, 15]. Hoon Ki's study, involving 141 consultants from a clinic, accords with these data [15]. The differences observed between blood pressure measurements when

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dressed, undressed, or with the sleeve up were not significant. The studies by Thien [16] and Ertug [17] showed the same result. In Tugrul's recent study of 200 relatively young individuals (average 33 years old), there was also no significant difference between blood pressure taken with or without clothing [18]. However, in this study, blood pressure, both systolic and diastolic, was found to be significantly higher when measured with the sleeve up, compared to the undressed or dressed arm. These results indicate that it would be more accurate to measure blood pressure with the cuff on clothing rather than with the cuff on a bare arm with the sleeve up.

The studies discussed above suggest that the sensitivity of current electronic blood pressure monitors can detect pulse waves accurately even through layers of fabric. The pulse wave from a humeral artery passes through human and textile tissues in the same way. The thickness of the bare arm, measured by its perimeter, seems to have more impact on blood pressure measurement than whether or not there is clothing [18].

The limitations of our study are mainly due to the study population, which cannot be compared to an ordinary ambulatory population or to healthy subjects. The patients studied were all on hemodialysis, and most of them elderly, and therefore often suffering from cardiovascular pathologies to varying degrees. The extreme values and the large standard deviation of the arterial pressure measurements testify to the large inter-individual variations usually observed in a population of dialysis patients in a center, with severity and heterogeneity of comorbidities inherent in this type of population (Tab. 1).

But this limitation is also the interesting feature of this study. The range of blood pressure in our sample is unique, with systolics ranging from 58 to 227 mmHg, and diastolics ranging from 27 to 110 mmHg (Tab. 2). The observed standard deviations are more than double those described in previous studies.

Another limitation is the fact that our analysis did not take into account the number and thickness of textile layers. We wanted to favor an approach in current practice, in which patients are treated in the condition in which they arrive, with their ordinary clothes.

CONCLUSION

The measurement of blood pressure by current electronic blood pressure monitors is sufficiently precise even without removing the clothes before the cuff is positioned on the arm. The difference observed with the classic measurement (cuff on bare arm) is small (<3 mmHg) and not very significant. In any case, this difference is not decisive with regard to a diagnostic or therapeutic approach. Consequently, in routine practice, this difference does not justify the undressing of patients for whom this procedure is difficult, uncomfortable or painful.

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CONFLICT OF INTEREST

The authors confirm that they have no conflict of interest with regard to this study.

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