SÃO PAULO MEDICAL JOURNAL

ORIGINAL ARTICLE

Manuel Carlos Martins de Castro, Décio Mion Jr., Marcello Marcondes, Emil Sabbaga

Seasonal variation of blood pressure in maintenance hemodialysis

Nephrology Division, Hospital das Clínicas, Faculdade de Medicina da Universidade de São Paulo - São Paulo, Brazil

Context: Seasonal variation in arterial blood pressure has been reported in studies with hypertensive and normotensive subjects. However, the influence of seasonal change on blood pressure of hemodialysis patients has not been reported. **Objective:** To investigate the seasonal variation of blood pressure in Brazil, a tropical country, in patients on hemodialysis. **Design**: Prospective, cohort study. **Setting**: Dialysis unit of a tertiary medical center (a teaching hospital of the University of São Paulo School of Medicine, São Paulo). **Patients**: Sixteen patients with chronic renal failure undergoing hemodialysis. **Outcomes**: Blood pressure, body weight, and ambient temperature were evaluated during 6 hemodialysis sessions carried out on 13 days during the four seasons. **Results**: The diastolic blood pressure was lower in summer than in fall and winter (95 ± 8 vs 107 ± 10 and 101 ± 10 mmHg, respectively; $p < 0.05$). The same was observed with mean blood pressure (116 ± 8 vs 130 ± 11 and 124 ± 9 mmHg, respectively; $p < 0.01$). On the other hand, the ambient temperature was higher in summer than in fall and winter (23.0 ± 1.6 vs 19.5 ± 3.0 and 15.8 ± 1.9 ºC, respectively; $p < 0.01$). **Conclusions**: We concluded that for patients with chronic renal failure the blood pressure has a seasonal variation with higher pressures in fall and winter than in summer. Thus, further studies are needed to elucidate the impact of this observation on the adjustment of antihypertensive treatment and on morbidity and mortality in maintenance dialysis patients.

Uniterms: Season. Blood pressure. Temperature. Chronic renal failure. Hemodialysis. Prospective cohort.

INTRODUCTION

Seasonal variation in blood pressure has been reported in studies with hypertensive and normotensive subjects.[1-6] Several reports have shown that both systolic and diastolic blood pressure are highest in winter. This pattern affects all ages, including children,[7,8] and the magnitude of this variation appears to increase with age.[1] The Medical Research Council of England studied seasonal variation of blood pressure in 17,000 treated or untreated hypertensive patients and observed that blood pressure increases by approximately 7/3 mmHg in the winter compared to the summer.[1]

Address for correspondence:
Manuel Carlos Martins de Castro
Rua Dr. Jesuíno Maciel, 239
São Paulo/SP, Brasil CEP 04739-000

The causes of seasonal variation in blood pressure are not clear, although some studies have reported an inverse correlation between blood pressure and environmental temperature.[1,9] Furthermore, a study carried out in Japan observed a blood pressure increase of 4/3 mmHg in the winter in association with elevated urinary catecholamine excretion.[5]

In the northern hemisphere mortality from cardiovascular disorders, including ischemic heart disease and stroke, is higher in winter than summer.[10,11] In patients undergoing chronic hemodialysis, the cardiovascular disease is associated with increased morbidity and mortality.[12] However, the influence of seasonal change on blood pressure of hemodialysis patients has not been reported. In this study we investigated the seasonal variation of blood pressure in patients undergoing hemodialysis and compared these observations to ambient temperature change in a tropical country.

METHODS

Sixteen patients with chronic renal failure undergoing hemodialysis at the University of São Paulo General Hospital entered this study after signing the informed consent. Eight were men and 8 women, 14 were white and two were black. Age ranged from 24 to 69 years (45 ± 12 years, mean ± SD) and hemodialysis time from 4 to 91 months (33 ± 24 months). Twelve (75%) patients were hypertensive (BP > 160 / 90 mmHg) and were receiving anti-hypertensive drugs including beta-blockers, calcium channel inhibitors or angiotensin-converting enzyme inhibitors. The patients were advised to take anti-hypertensive medication until the night preceding the hemodialysis session and the adjustments of prescription were carried out according to the assistant physician. The 24-hour urinary volume was less than 100 ml in all of the patients.

The patients were studied from January to December 1992, in São Paulo, Brazil. Brazil is a tropical country in the southern hemisphere and the four seasons are defined as summer (January, February and March), fall (April, May and June), winter (July, August and September) and spring (October, November and December). Each patient was evaluated during 6 consecutive hemodialysis sessions, carried out over 13-day intervals, from February 17 to 29 (summer), May 18 to 30 (fall), August 17 to 29 (winter) and November 16 to 28 (spring).

The study was done on an outpatient basis. Before and after the hemodialysis the body weight and the blood pressure was measured on the arm opposite the arteriovenous fistula. The blood pressure was measured twice after 5 minutes in a supine position by a trained renal nurse.

Patients received hemodialysis treatment three times a week, 4 hours each session, with a dialysate containing sodium (140 mEq/l), potassium (1.0 mEq/l), calcium (3.5 mEq/l), and bicarbonate (35 mEq/l). During hemodialysis, all patients were ultrafiltrated to maintain their hydratation status at dry weight. Kt/V was 1.19 ± 0.12.

Environmental temperature recordings were provided by the Brazilian Air Force and correspond to the temperature recorded at Congonhas Airport (São Paulo). The temperature was recorded in Centigrade, at one-hour intervals for 24 hours. For each season, the temperature is the average of the 13 consecutive days.

Data are expressed as mean ± SD. Mean blood pressure was calculated as 1/3 of the systolic blood pressure plus 2/3 of the diastolic blood pressure. Statistical evaluation was done by Student's paired t test and variance analysis for repeated measures (Anova) followed by Bonferroni's test. Statistical significance was accepted as $p < 0.05$.

RESULTS

In the 16 patients studied, the body mass index (Kg/m^2) was 22.5 ± 3.0 (range 16.5 to 29.7). For men it was 22.9 ± 2.8 (21.2 to 29.7) and for women it was 22.1 ± 3.3 (16.5 to 25.2). Table I shows the ambient temperature, interdialysis body weight gain, hemoglobin and blood pressure for each season. Although the average temperature was significantly higher in summer there was no change in body weight gain in the interdialytic interval and in hemoglobin. On the other hand, both diastolic and mean blood pressure pre-hemodialysis were significantly lower in summer than in fall, winter and spring. Table 1 also shows that hemodialysis was effective in decreasing post-dialysis blood pressure in every season of the year.

DISCUSSION

Several studies have shown seasonal variation in blood pressure in both normotensive and hypertensive subjects.[1-6] However, none of them showed this variation in patients with chronic renal failure. Thus, this is the first study to demonstrate that seasonal change in blood pressure is also observed in patients undergoing hemodialysis.

Most of the studies made comparisons between summer and winter and showed an increase in blood pressure in winter. In our study, in sharp contrast to what had previously been reported,[11,13] a more intense blood pressure increase was observed in the fall, when the ambient temperature was higher than in winter. The reasons for this are not clear. These results are the opposite to Rose's study,[14] in which blood pressure peak values occurred in the spring rather than in the winter. These discrepancies might result from climatic differences between the geographic sites covered by the two studies.

In the summer, peripheral vasodilatation is associated with an increase in cardiac output. On the other hand, in the winter peripheral vasoconstriction is associated with a decrease in cardiac output. Since there is an increase in plasma norepinephrine[5,15] and urinary excretion of catecholamines[5] in the winter, it is plausible to assume that seasonal blood pressure adaptation requires activation of the sympathetic nervous system, which is present in patients with chronic renal failure undergoing dialysis.[16,17]

In accordance with studies where blood pressure measurements were casual, those involving non-invasive outpatient blood pressure recordings have reported blood

Table 1
Seasonal variation of ambiental temperature, interdialysis body weight gain, hemoglobin and diastolic and mean blood pressure.

	Summer	Fall	Winter	Spring
Temperature (°C)	23.0 ± 1.6	19.5 ± 3.0 [c]	15.8 ± 1.9 [c]	20.1 ± 2.7 [b]
Body weight (kg)	2.1 ± 0.9	2.1 ± 0.9	2.2 ± 0.9	2.1 ± 0.6
Hemoglobin (g%)	7.7 ± 1.5	7.4 ± 1.3	7.7 ± 1.4	8.7 ± 1.9
DBP before HD	95 ± 8	107 ± 10 [c]	101 ± 10 [b]	101 ± 8 [b]
(mmHg) after HD	87 ± 7 [a]	96 ± 10 [a]	89 ± 9 [a]	91 ± 9 [a]
MBP before HD	116 ± 8	130 ± 11 [c]	124 ± 9 [c]	124 ± 12 [b]
(mmHg) after HD	104 ± 13 [a]	116 ± 14 [a]	108 ± 12 [a]	112 ± 11 [a]

a = $p < 0.01$ before vs after HD
b = $p < 0.05$; c = $p < 0.01$ vs summer

pressures higher in cold than in warm seasons.[18] Thus, our observations may influence the decision to start antihypertensive therapy in patients undergoing dialysis. In addition, it is possible that for these patients the adjustment of anti-hypertensive medication should be carried out in summer and in the beginning of the cooler months.

Seasonal blood pressure variation is observed in all age groups[7,8] and, at least for patients with hypertension, this variation is higher in older than in younger subjects.[1] This is relevant in patients undergoing dialysis, since the mean age in this population is increased.[19,20]

Seasonal blood pressure change is also greater in thin than obese subjects.[1] It is possible that body fat provides thermal isolation[21] and increased body fat might lessen the degree of centrally controlled vasoconstrictor response to cooling. Since body mass index is lower in hemodialysis patients, this might account for higher seasonal variation blood pressure.

In our study the anti-hypertensive therapy was not a controled variable and 75% of the patients were receiving anti-hypertensive drugs when blood pressure measurements were performed. In this way, the Medical Research Council of England[1] showed that, at least for patients with mild hypertension, there was no evidence that treatment influenced seasonal variation in arterial blood pressure. However, for patients on dialysis future studies are necessary to confirm that anti-hypertensive therapy does not influence seasonal variation in arterial blood pressure.

Hata et al.[5] reported that in normal subjects and in patients with essential hypertension, urinary sodium excretion was higher in winter than in summer. The authors reported that in winter there is an increase in caloric intake, which may be attributable to increased demands for body heat production. In addition, there might be greater salt ingestion in winter with a blood pressure increase. In our patients urinary sodium excretion did not contribute to sodium homeostasis. Furthermore, in our patients interdialysis body weight gain was similar in all seasons, suggesting that sodium intake was the same. However, another possibility is an increased sodium loss in sweat in summer[22] with higher blood pressure decrease in summer.

In the northern hemisphere the higher winter mortality from ischemic heart disease and cerebral vascular disorder is well known.[23,24] In England and Wales, mortality from ischemic heart disease is 50% higher in winter than in summer[23] and Bull and Morton reported similar findings in New York.[25] There is evidence to suggest that cardiovascular risk becomes greater as blood pressure increases.[26,28] Therefore, it is possible that the cardiovascular risk is greater in winter. However, the impact of seasonal variation in the mortality of patients undergoing dialysis has not been studied, although it is well known that, in this population, cardiovascular mortality increases in the presence of hypertension.[29,30] Finally, this study confirms that hemodialysis treatment is accompanied by control of blood pressure[31] and adds the information that this effect is not influenced by environmental temperature.

In conclusion, our observations suggest that for patients with chronic renal failure the blood pressure has a seasonal variation with higher pressures in fall and winter than in summer. Thus, further studies are needed to elucidate the impact of this observation in morbidity and mortality in maintenance dialysis patients.

REFERENCES

1. Brennan PJ, Greenberg G, Miall WE, Thompson SG. Seasonal variation in arterial blood pressure. BMJ 1982;285:919-23.
2. Khaw KT, Barrett-Connor E, Suarez L. Seasonal and secular variation in blood pressure in man. J Card Rehab 1984;4:440-4.
3. Thulin T, Bengtsson B, Schersten B. Assessment of causal blood pressure variations. Postgrad Med J 1978;54:10-5.

4. Kesteloot H, Van Houte. An epidemiologie survey of arterial blood pressure in a large male population group. Am J Epidemiol 1974;99:14-29.
5. Hata T, Ogihara T, Maruyama A, et al. The seasonal variation of blood pressure in patients with essential hypertension. Clin Exp Hypertens 1982;A4(3):341-4.
6. Giaconi S, Palombo C, Genovesi-Ebert A, Marabotti C, Volterrani D, Ghione S. Long-term reproducibility and evaluation of seasonal influences on blood pressure monitoring. J Hypertens 1988;6suppl 4:S64-6.
7. De Swiet M, Fayers PM, Shinebourne EA. Blood pressure in four and five-year-old children: the effects of environment and other factors in its measurement. J Hypertens 1984;2:501-5.
8. Jenner DA, English DR, Vandongen R, Beilin LJ, Armstrong BK, Dunbar D. Environmental temperature and blood pressure in 9-year-old Australian children. J Hypertens 1987; 5:683-6.
9. Heller RF, Rose G, Tunstall - Pedoe HD, Christie DGS. Blood pressure measurement in the United Kingdom heart disease prevention project. J Epidemiol Commun Health 1978;32:235-8.
10. Curwen M, Devis T. Winter mortality, temperature and influenza: has the relationship changed in recent years? Popul Trends 1988;54:17-20.
11. Curwen M. Excess winter mortality: a British phenomenon? Health Trends 1990/1991;22:169-75.
12. Agodoa LYC, Blagg CR, Held PJ, Port FK. Survival and mortality; United States Renal Data System 1990. Annual Report. Am J Kidney Dis 1990;16suppl 2:44-52.
13. Woodhouse PR, Khaw KT, Plummer M. Seasonal variation of blood pressure and its relationship to ambient temperature in an elderly population. J Hypertens 1993;11:1267-74.
14. Rose G. Seasonal variation in blood pressure in man (letter). Nature 1961;189:235.
15. Izzo Jr JL, Larrabee PS, Sander E, Lillis LM. Hemodynamics of seasonal adaptation. Am J Hypertens 1990;3:405-7.
16. Izzo Jr JL, Sterns RH. Abnormal norepinephrine release in uremia. Kidney Int 1983;24suppl 16:S221-3.
17. Converse-Jr RL, Jacobsen TN, Toto RD, et al. Sympathetic overactivity in patients with chronic renal failure. N Engl J Med 1992;327:1912-8.
18. Giaconi S, Palombo C, Ebert AG, Marabotti C, Volterrani D, Ghione S. Long-term reproducibility and evaluation of seasonal influences on blood pressure monitoring. J Hypertens 1988;6suppl 4:S64-6.
19. Eggers PW. Mortality rates among dialysis patients in Medicare's end-stage renal disease program. Am J Kidney Dis 1990;15:414-21.
20. Brunner FP, Selwood NH. Results of renal replacement therapy in Europe, 1980 to 1987. Am J Kidney Dis 1990;15:384-96.
21. Hayward MG, Keatinge WR. Roles of subcutaneous fat and thermoregulatory reflexes in determining ability to stabilize body temperature in water. J Physiol (Lond) 1981;320:229-51.
22. Costill DL. Sweating: its composition and effects on body fluids. Ann NY Acad Sci 1977;301:160-74.
23. Bull GM. Meteorological correlates with myocardial and cerebral infarction and respiratory disease. British Journal of Preventive and Social Medicine 1973;27:108-13.
24. Rose G. Cold weather and ischaemic heart disease. British Journal of Preventive and Social Medicine 1966;20:97-100.
25. Bull GM, Morton J. Environment, temperature and death rates. Age Ageing 1978;7:210-4.
26. Rose G. Strategy of prevention: lessons from cardiovascular disease. BMJ 1981;282:1847-51.
27. Khaw KT, Barrett-Connor E, Suarez L, Criqui MH. Predictors of stroke - associated mortality in the elderly. Stroke 1984;15:244-8.
28. Barrett-Connor E, Suarez L, Khaw KT, Criqui MH, Wingard DL. Ischemic heart disease risk factors after age 50. J Chronic Dis 1984;37:903-8.
29. Heyra RJ, Paganini EP. Blood pressure control in chronic dialysis patients. In: Maher JF, editor. Replacement of renal function by dialysis 3rd ed Boston: Kluwer Academic Publishers 1989;772-87.
30. Charra B, Calemard E, Cuche M, Laurent G. Control of hypertension and prolonged survival in maintenance hemodialysis. Nephron 1983;33:96-9.
31. Vertes V, Cangiano JL, Berman LB, Gould . Hypertension in end-stage renal disease. N Engl J Med 1969; 280:978-81.

Resumo

Objetivo: Variação sazonal na pressão arterial foi relatada em estudos com indivíduos hipertensos e normotensos. Porém, a influência de variação sazonal na pressão sangüínea de pacientes em hemodiálise não foi relatada. Neste estudo nós investigamos a variação sazonal da pressão sangüínea no Brasil, um país tropical, em pacientes em programa de hemodiálise. **Tipo de estudo**: Estudo clínico prospectivo. **Local:** Unidade de diálise de um centro médico terciário (Hospital de ensino da Faculdade de Medicina da Universidade de São Paulo – São Paulo). **Pacientes**: 16 pacientes com insuficiência renal crônica em programa de hemodiálise. **Variáveis:** Registro da pressão arterial, peso corpóreo e temperatura ambiente durante seis sessões de hemodiálise, realizadas em 13 dias durante as quatro estações do ano. **Resultados**: A pressão arterial diastólica foi menor no verão que no outono e inverno (95 ± 8 vs 107 ± 10 e 101 ± 10 mmHg, respectivamente; p <0,05). O mesmo foi observado para a pressão arterial média (116 ± 8 vs 130 ± 11 e 124 ± 9 mmHg, respectivamente; P <0,01). Por outro lado, a temperatura ambiental foi mais alta no verão que no outono e inverno (23.0 ± 1.6 vs 19.5 ± 3.0 e 15.8 ± 1.9 ºC, respectivamente; p <0,01). **Conclusões**: Nós concluímos que para pacientes com insuficiência renal crônica a pressão sangüínea tem uma variação sazonal com pressões mais altas no outono e inverno que no verão. Sendo assim, estudos adicionais são necessários para elucidar o impacto desta observação no ajuste do tratamento anti-hipertensivo e na morbidade e mortalidade de pacientes em programa de diálise.