

## CONVENTIONAL AND CHRONOBIOLOGIC OUTPUT FROM BLOOD PRESSURE SCREENING BY 7-DAY OR 24-HOUR MONITORING

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### Abstract

The study was aimed at analysing the sphygmochron, a 24-hour blood pressure record based on a computer comparison of a given subject's data with time-specified reference limits of clinically healthy peers of the same gender and age. Sphygmochrons provide, by complementary (parametric and nonparametric) approaches, an inferential statistical basis for the diagnosis of blood pressure disorders. A sphygmochron may further be used to indicate the need for therapy and the timing of treatment and assessment of its effects.

### Key words

Blood pressure monitoring, Circadian rhythm, Blood pressure disorder

### INTRODUCTION

Considering the extent of hour-to-hour and day-to-day variability in blood pressure (1–3), around-the-clock monitoring for 7 days has been recommended to detect blood pressure overswinging or circadian hyper-amplitude-tension (CHAT), and also to reduce the number of false positive and false negative diagnoses (4, 5). St. Anne's Teaching Hospital (Brno, Czech Republic), Tokyo Women's Medical University, and the city of Urausu, Hokkaido, Japan, along with the Halberg Center at the University of Minnesota in Minneapolis, are currently offering the 7-day or 24-hour screening to interested parties. Evaluation of the results from analyses of the data prompted by such projects is facilitated by the integration of different procedural steps in an updated sphygmochron (6; Fig. 1). For diagnosis and treatment, we propose the sphygmochron, a 24-hour blood pressure record based on a computer comparison of a given subject's data with time-specified reference limits of clinically healthy peers of the same gender and age.

## MATERIALS AND METHODS

Ambulatory blood pressure monitors used were the ABPM-630 from Colin Electronics (Komaki, Japan) and the TM-2421 from A&D (Tokyo, Japan). Software offered by A&D for downloading data from the monitor to a PC computer was based on Microsoft Excel. A short form of the sphygmochron (6) was used to streamline different steps leading to a report in order to help the health care provider make an informed decision regarding treatment when parameters lay outside acceptable chronobiologic limits in the range that had been specified for clinically healthy peers of corresponding gender and age.

On an individual basis, the sphygmochron, a computer comparison of the subject's profile in the light of time-specified reference limits derived from healthy subjects matched by gender, age and ethnicity, served to ascertain parametrically that blood pressure was, most of the time, within peer group limits and that the hyperbaric index reduced below 50 mm Hg x h during 24 h was even eliminated. Alternatively, it prompted interventions in order to achieve this goal value.

An excess, depicted by the hyperbaric index or a deficit depicted by the hypobaric index, namely the numerical integrations between the area under the curve of blood pressure, when it is outside reference limits, and the limit itself are shown in *Fig.1*.

## RESULTS

The results presented in *Fig. 2* show that the percent of time elevation should be complemented by the hyperbaric index (an extent of excess) since two patients with a very similar percent time elevation can have a highly different excess (area under the curve). The timing of excess in the sphygmochron was also helpful for guiding the timing of treatment. Longitudinal monitoring of blood pressure before the start of anti-hypertensive treatment and during the treatment provided an individualised assessment of the patient's response to treatment. A 60-year-old man was found to have an unduly elevated systolic and diastolic blood pressure for 49% and 10% of the time, respectively, with the corresponding hypotensive values of 76 and 31 mm Hg x h during 24 h during an 8-day monitoring span in the absence of treatment. During the ensuing 6 years, repeated profiles for 2–10 days with no undue blood pressure excess indicated that his treatment with 25 mg hydrochlorothiazide, a diuretic taken in the morning at breakfast, was effective.

## DISCUSSION

The sphygmochron can help the physician to prescribe medication to be taken in such a way that it lowers blood pressure during the spans when the individual would have high values if left untreated. This timing of treatment not only makes the medication more effective but also helps to avoid reduction of blood pressure during spans when it is already low. This side-effect of treatment causes the dizziness that some people experience when they are taking medication for high blood pressure. A follow-up sphygmochron can be completed while the patient takes medication, often allowing the physician to reduce or reschedule dosages and thus helping to prevent undesirable or harmful side-effects.

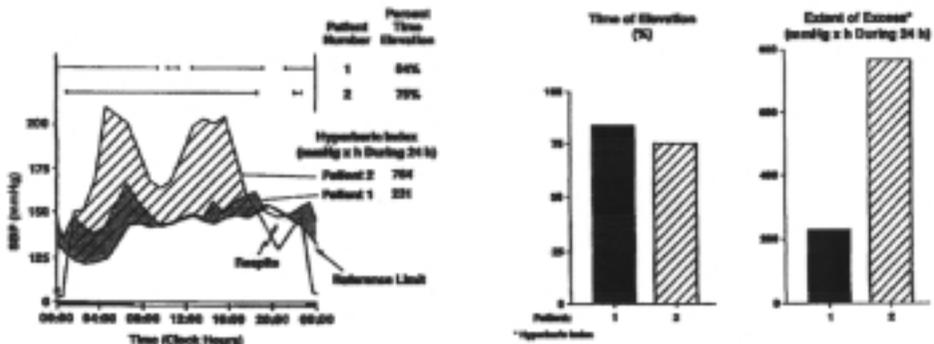


Fig. 1

Non-parametric approach to deviant blood pressure (its excess or deficit)

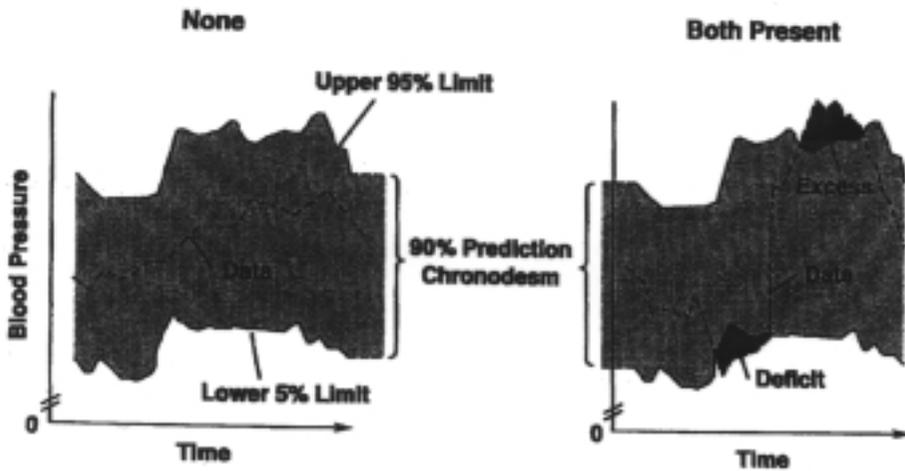


Fig. 2

The results of the 24-hour ambulatory monitoring of two patients who had similar values of systolic blood pressure, expressed in percentages, above the time-specified reference limits but differed markedly in the overall extent of excess.

Chronobiologic analyses are complemented by the computation of conventional endpoints such as the 24-hour mean, daytime and night time means and the day-to-night ratio (DNR). These indices are computed for the whole period as well as for each separate day for systolic (S) and diastolic (D) blood pressure (BP) and heart rate (HR) and for other variables derived from them, namely mean arterial pressure ( $MAP=(SBP+2DBP/3)$ ), pulse pressure ( $PP = SBP - DBP$ ) and the double product ( $DP = SBP \times HR/100$ ). Provisions are also made to adjust the computation of DNR to the subject's actual rest/activity routine. The plotting of routines also helps to visualise the main features of these data.

Sphygmochrons provide, by complementary (parametric and nonparametric) approaches, an inferential statistical basis for the diagnosis of blood pressure disorders and therefore indicate the need for treatment and its timing and also for assessing treatment effects.

#### A c k n o w l e d g e m e n t

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#### KONVENČNÍ A CHRONOBIOLOGICKÝ PŘÍNOS AMBULANTNÍHO SEDMIDENNÍHO A DVACETIČTYŘHODINOVÉHO MONITOROVÁNÍ KREVNIHO TLAKU

#### S o u h r n

Cílem studie bylo analyzovat metodu "sphygmochron", což je souhrn monitorování krevního tlaku založený na počítačovém srovnání změřených dat pacienta s limity referenčních hodnot zdravých osob, srovnávaných dle pohlaví, věku a časového průběhu. Tato metoda poskytuje, spolu s doplňujícími (parametrickými a neparametrickými) přístupy, statistický základ diagnózy poruch krevního tlaku a indikuje potřebu časování léčby a zhodnocení léčebného účinku.

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