DURATION OF ABPM AS AN IMPORTANT PREREQUISITE FOR A RELIABLE DIAGNOSIS OF VASCULAR VARIABILITY DISORDERS (VVDS)

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ABPM records from 26 clinically healthy residents of Tosa City, Japan over 6 or 7 days were analyzed overall and day-by-day in order to determine the frequency of occurrence of vascular variability abnormalities (VVAs) and the extent of reproducibility of the results from one day to another. ABPM records over 18 to 33 hours from 360 patients of a specialized cardiology clinic in Almaty (Kazakhstan) with cardiovascular diseases of medium or high severity were also analyzed.

Among all records from Tosa City, at least one VVA was found on at least one day in all residents. Twelve subjects with no overall abnormality had VVAs in 1 to 3 days. Of the remaining 14 subjects, only one had no overall abnormality but at least one VVA in 6 of 7 days. The other 13 had at least one VVA in 4 or more days as well as an overall abnormal record One or more VVAs occurred in 78% of the cardiac patients in Almaty. More than one type of VVA was found in 50% of the patients. In 22% of cardiac patients no VVA was found, despite the fact that these patients had cardiovascular diseases. The large day-to-day variability in circadian characteristics of blood pressure and heart rate observed in Tosa City and the associated presence or absence of VVA(s) on a given day indicate the need to monitor for longer than 24 hours and to repeat the monitoring once a VVA is detected, until historically feasible lifelong monitoring can be implemented.

Key words: ambulatory monitoring, blood pressure, heart rate, sphygmochron, vascular variability disorders.

Automatic around-the-clock measurements of blood pressure (BP) and heart rate (HR) by ambulatory monitoring (ABPM) in clinical health served to derive time-specified reference limits computed as 90% prediction limits specified by gender and age [1]. Data are analyzed by sphygmochron [2—4], consisting of parametric and non-parametric assessments. Parametrically, by least squares (Figure 1), a two-component

model, consisting of cosine curves with anticipated periods of 24 and 12 hours, is fitted to the data (Figure 2) yielding estimates of the MESOR (M), 24-hour and 12-hour double amplitudes (2A) and acrophases (□) [5—7].

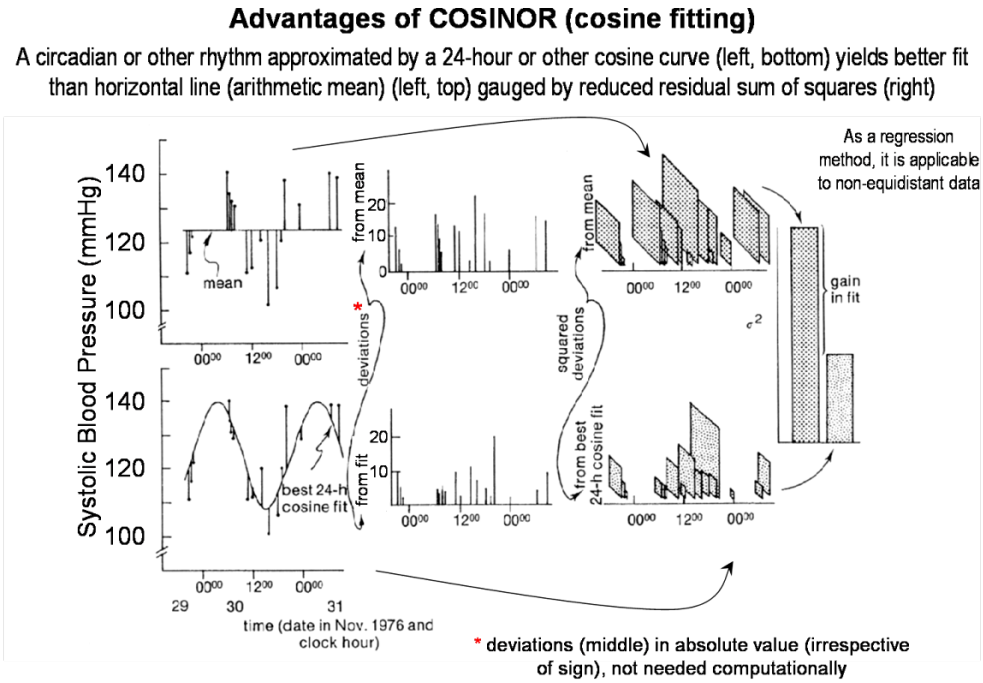


Figure 1. Illustration of the principle of least squares underlying the extended cosinor method

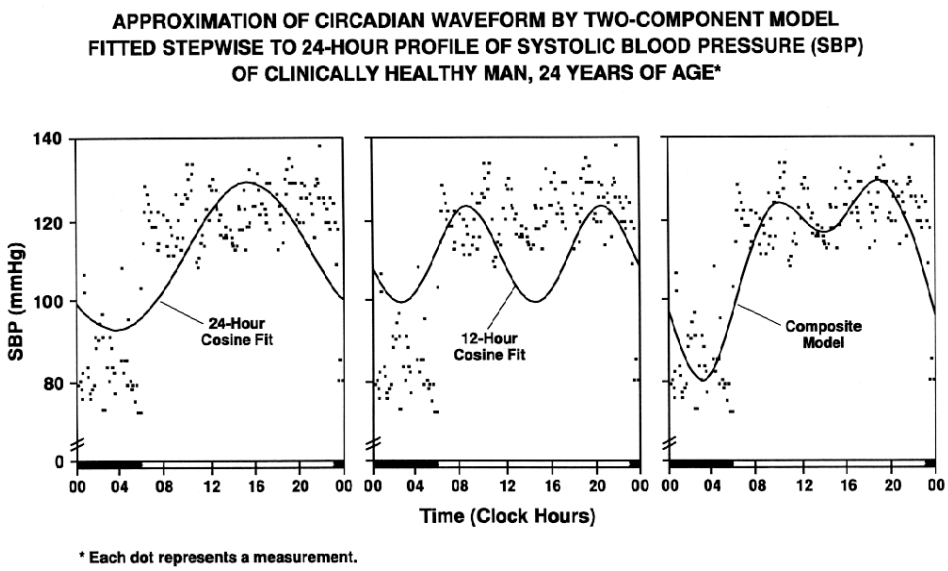


Figure 2. Fit of 2-component model to systolic blood pressure (SBP) data

Reference limits, also computed as 90% prediction limits separately for men and women of different age groups are derived for M, 2A and from records in clinical health. This model usually provides a good approximation of the decrease during rest, the small increase around mid-sleep followed by a more rapid increase around awakening, a post-prandial dip that is more accentuated with increasing age, and the evening slower decrease (Figure 3) [8].

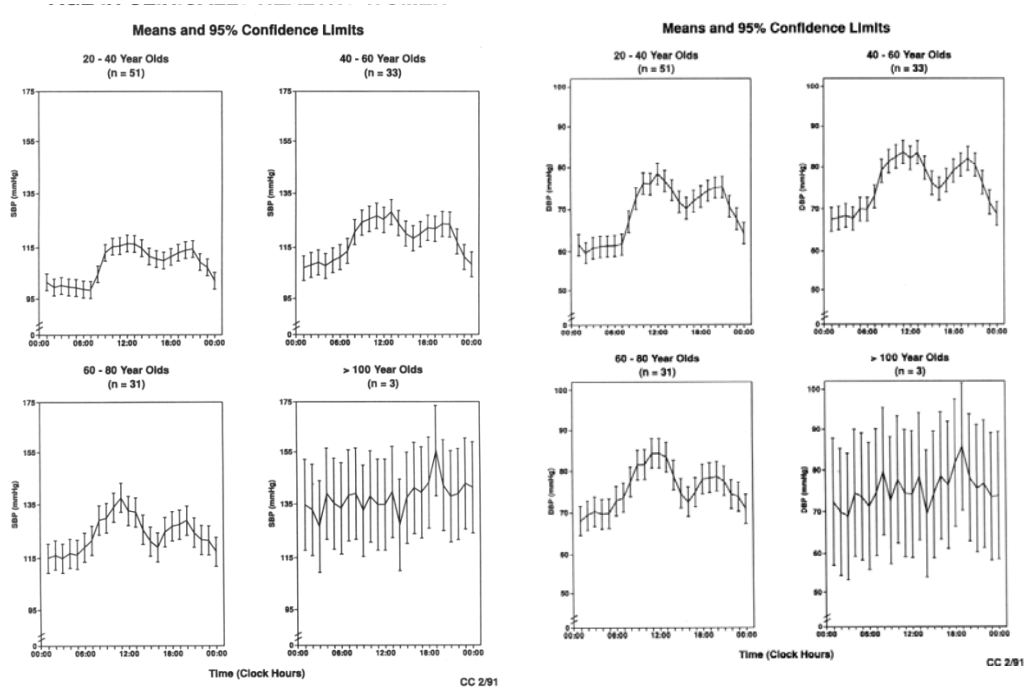


Figure 3. Circadian waveform of systolic (left) and diastolic (right) blood pressure in four age groups

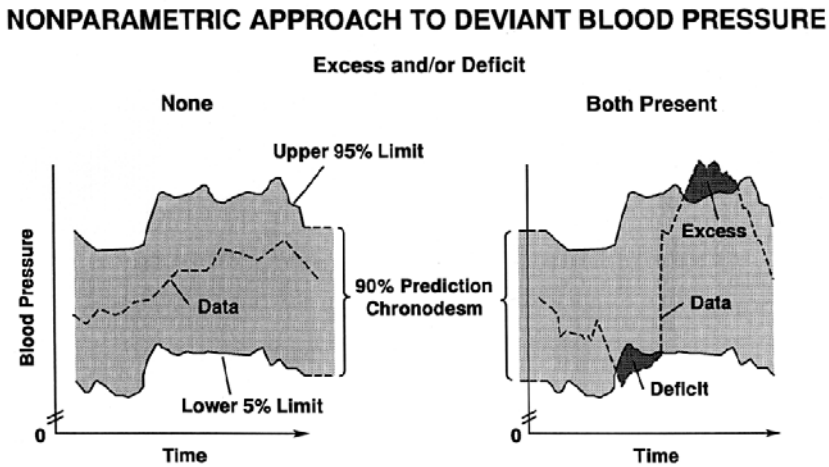


Figure 4. Nonparametric approach to blood pressure assessment

Non-parametrically, percentage time elevation, area of excess and timing of largest excess are determined by numerical integration (Figure 4). In addition to MESOR-hypertension, deviations from these chronobiological norms lead to diagnoses of CHAT and/or ecphasia when the 24-hour BP–2A is excessive and/or the 24-hour BP-□ is outside acceptable limits but the 24-hour HR-□ is acceptable. These conditions along with an excessive pulse pressure (above 60 mmHg) and a deficient HR variability (standard deviation of HR < 7.5 beats/min) constitute Vascular Variability Anomalies (VVAs) when present during one or a few days, or Vascular Variability Disorders (VVDs) when the abnormalities are confirmed over repeated week-long records in the absence of a persisting load [4]. Any two or more coexisting VVDs are referred to as Vascular Variability Syndromes (VVSs).

Table 1

Number of days with at least one VVA will have to be complemented by the extent of severity of VVA(s) each day and overall *

N of days with a VVA	N of subjects	VVA in weeklong record?		Comments
		No	Yes	
0	0			
1	3	3	0	
2	7	7	0	
3	2	2	0	
4	6	4	2	1 VVA each (S-CHAT)
5	4	2	2	1 D-MH; 1 S-&D-CHAT
6	1	1	0	
7	3	0	3	1 S-CHAT; 2 with 3 VVAs**

* One can have 6 days with a VVA and no abnormality in the overall record (row 7), a finding suggesting that the duration of a VVA is an incomplete measure, the extent of abnormality also in need of being assessed. Continuous recording with automatic analyses carried out both day-to-day and week-to-week is recommended in any event once a validated, unobtrusive monitor is miniaturized and rendered affordable in a chronobiologic system subservient to health monitoring, including mental and other strain assessment, with dividends for medical research and for monitoring effects of natural environmental factors, including solar activity.

** 1 with S-MH, EPP and S-CHAT and 1 with S-MH, EPP and DHRV. VVA: Vascular Variability Anomaly; S — (Systolic); D — (Diastolic); MH: MESOR-Hypertension; CHAT Circadian Hyper-Amplitude-Tension; EPP: Excessive Pulse Pressure (> 60 mm Hg); DHRV: Deficient Heart Rate Variability (standard deviation of HR < 7.5 beats/minute).

ABPM records from 26 residents (4 men and 22 women 39—74 years of age) of Tosa City, Japan over 6 or 7 days (2 and 24 profiles, respectively) were analyzed overall and day-by-day in order to determine the frequency of occurrence of abnormalities and the extent of reproducibility of the results from one day to another. Among all 26 records, at least one VVA is found on at least one day in all residents. Twelve subjects with no overall abnormality had a VVA in 1 to 3 days. Of the remaining 14 subjects, only one had no overall abnormality but at least one VVA in 6 of 7 days. Her data are plotted as a function of time in Figure 5, with an indication of VVAs detected on a daily basis. Her overall sphygmochron and circadian profiles of systolic and diastolic BP are shown in Figure 6. The other 13 had at least one VVA in 4 or more days as well as an overall abnormal record, Table 1. The 3 individuals with abnormality on all 7 days also have an abnormal 7-day record, one with only systolic CHAT, the other two with 3 VVDs, including systolic MESOR-Hypertension and an excessive pulse pressure together with either systolic CHAT or deficient HR variability, Table 1.

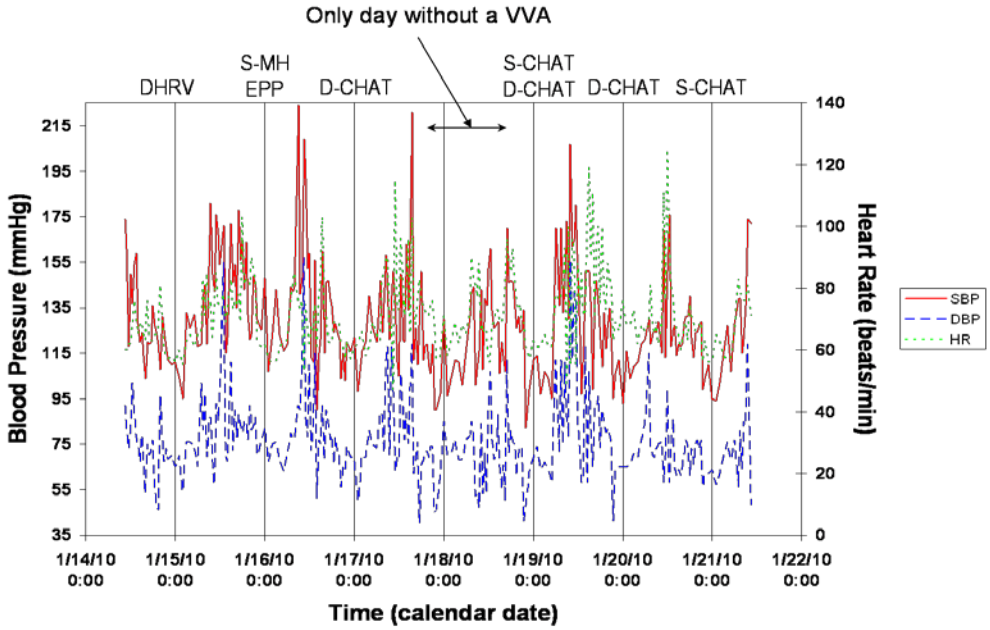
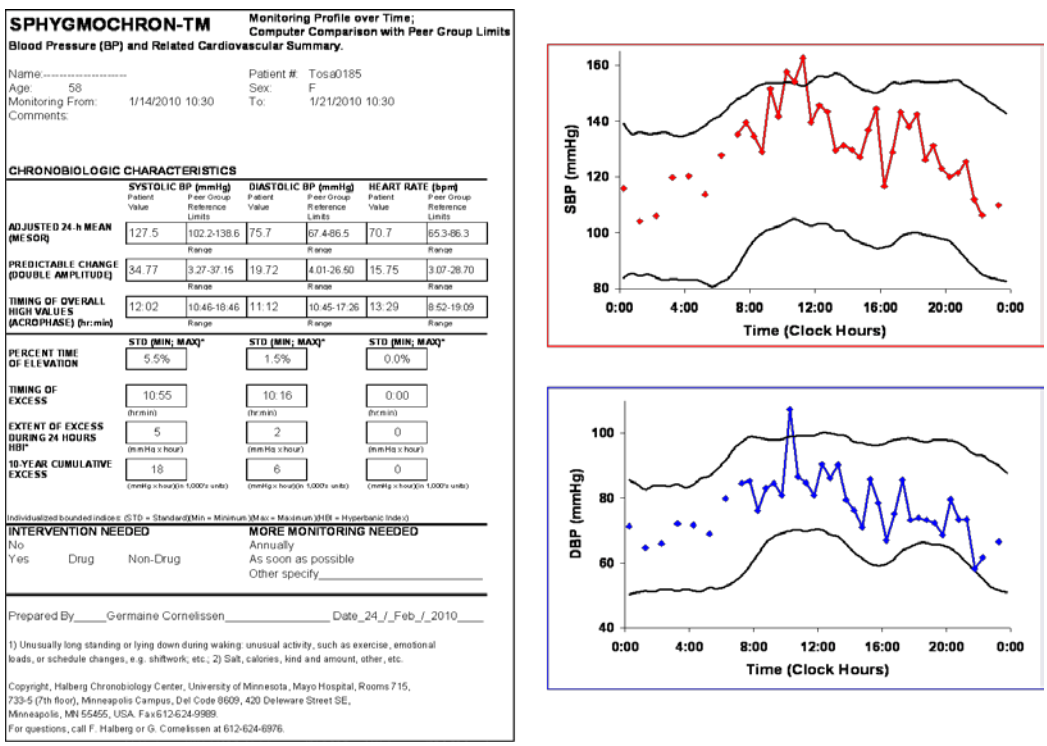


Figure 5. Day-to-day variability in BP and HR behavior. In this record, there is at least one VVA on 6 of 7 days. The overall summary shows all endpoints to be within acceptable limits (Fig. 6).



SPHYGMOCHRON-TM — Monitoring Profile over Time; Computer Comparison with Peer Group Limits

Blood Pressure (BP) and Related Cardiovascular Summary.

Name:---------- Patient #: Tosa0185
Age: 58 Sex: F
Monitoring From: 1/14/2010 10:30 To: 1/21/2010 10:30
Comments:

CHRONOBIOLOGIC CHARACTERISTICS

	SYSTOLIC BP (mmHg) Patient Value	SYSTOLIC BP (mmHg) Peer Group Reference Limits	DIASTOLIC BP (mmHg) Patient Value	DIASTOLIC BP (mmHg) Peer Group Reference Limits	HEART RATE (bpm) Patient Value	HEART RATE (bpm) Peer Group Reference Limits
ADJUSTED 24-h MEAN (MESOR)	127.5	102.2-138.6 Range	75.7	67.4-86.5 Range	70.7	65.3-86.3 Range
PREDICTABLE CHANGE (DOUBLE AMPLITUDE)	34.77	3.27-37.15 Range	19.72	4.01-26.50 Range	15.75	3.07-28.70 Range
TIMING OF OVERALL HIGH VALUES (ACROPHASE) (hr:min)	12:02	10:46-18:46 Range	11:12	10:45-17:26 Range	13:29	8:52-19:09 Range
	STD (MIN; MAX)*		STD (MIN; MAX)*		STD (MIN; MAX)*	
PERCENT TIME OF ELEVATION	5.5%		1.5%		0.0%	
TIMING OF EXCESS	10:55 (hr:min)		10:16 (hr:min)		0:00 (hr:min)	
EXTENT OF EXCESS DURING 24 HOURS HBI*	5 (mmHg x hour)		2 (mmHg x hour)		0 (mmHg x hour)	
10-YEAR CUMULATIVE EXCESS	18 (mmHg x hour)(in 1,000's units)		6 (mmHg x hour)(in 1,000's units)		0 (mmHg x hour)(in 1,000's units)	

Individualized bounded indices: (STD = Standard)(Min = Minimum)(Max = Maximum)(HBI = Hyperbaric Index)

INTERVENTION NEEDED
No
Yes Drug Non-Drug

MORE MONITORING NEEDED
Annually
As soon as possible
Other specify_____

Prepared By_____Germaine Cornelissen_____ Date_24_/_Feb_/_2010____

1) Unusually long standing or lying down during waking: unusual activity, such as exercise, emotional loads, or schedule changes, e.g. shiftwork; etc.; 2) Salt, calories, kind and amount, other, etc.

Figure 6. Overall sphygmochron of subject whose data are shown in Figure 5. Stacking of the systolic and diastolic BP data in the light of reference limits reveals only minor BP excess

The number of abnormal days in a weeklong record as such does not tell whether the 7-day record is also abnormal, a finding suggesting that the duration of a VVA is an incomplete measure, to be complemented by information on the extent of abnormality. Weeklong records were found to be abnormal in over 25% of the residents, a reason for recommending a follow-up 7-day profile once abnormality is detected in the first 7-day record, yet week-to-week variability underscores the need for unobtrusive, affordable instrumentation for continued monitoring of mental strain, gauged by VVAs.

Among treated cardiac patients in Almaty, 22% of patients had no VVA, whereas 50% had multiple VVAs. Outcome studies have shown that cardiovascular disease risk increases with the presence of each additional VVA [3, 4, 8, 9]. It is thus critical to be able to reliably detect the presence of VVAs so that non-drug or drug intervention can not only lower an elevated blood pressure but also restore healthy circadian variability patterns of blood pressure and heart rate. To do this, monitoring over spans longer than 24 hours is needed, with the further recommendation to repeat a 7-day profile once abnormality is detected. Particularly in the case of cardiac patients in need of treatment, repeated if not continuous monitoring is advocated as a means of self-surveillance, so that any undesirable change in blood pressure and/or heart rate variability can promptly be addressed. What may appear as utopia to some physicians is routine pressure measurement in the tires of some cars. The technology is available. Why do not use it in those who do and do not drive cars? The answer depends on the demand of the readers.

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ПРОДОЛЖИТЕЛЬНОСТЬ МОНИТОРИРОВАНИЯ АРТЕРИАЛЬНОГО ДАВЛЕНИЯ КАК ВАЖНАЯ СОСТАВЛЯЮЩАЯ НАДЕЖНОЙ ДИАГНОСТИКИ НАРУШЕНИЙ ВАРИАБЕЛЬНОСТИ ГЕМОДИНАМИЧЕСКИХ ПОКАЗАТЕЛЕЙ

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Были проанализированы данные мониторирования АД и ЧСС у 26 практически здоровых людей (4 мужчин и 22 женщин в возрасте 39—74 лет, проживающих в городе Тоса, Япония). Данные собраны на протяжении 6 суток (в 2 случаях) или 7 суток (в 24 случаях) и анализировались в целом и по отдельным суткам с целью определения частоты появления аномалий вариабельности гемодинамических показателей (АВГП) и степени воспроизводимости результатов от одного дня к другому. Для сравнения были проанализированы также записи СМАД продолжительностью 18—33 часа 360 пациентов специализированной кардиологической клиники г. Алматы (Казахстан) с заболеваниями сердечно-сосудистой системы средней и высокой степени тяжести.

Среди всех 26 записей из города Тоса по крайней мере одна АВГП обнаружена как минимум в один из дней у всех испытуемых. У двенадцати человек, не имевших отклонений суммарных показателей, в одной—трех суточных записях были обнаружены АВГП. Из оставшихся 14 пациентов только одна женщина не имела отклонений при анализе регистрограммы в целом, но у нее наблюдались не менее одной АВГП в течение 6 из 7 суток мониторирования. У остальных 13 человек с отклонениями суммарных показателей обнаружено по меньшей мере по одной АВГП в течение 4 дней и более. Одна или более АВГП отмечены у 78% кардиологических больных в г. Алматы. У 50% этих больных наблюдалось более одного типа АВГП. Примечательно, что в 22% случаев у кардиологических больных не выявлено АВГП при мониторировании указанной длительности. Высокая вариабельность циркадианных характеристик АД и ЧСС от одних суток к другим у здоровых людей, приводившая к появлению у них в некоторые дни АВГП, а также отсутствие АВГП у 22% кардиологических больных при небольшой продолжительности мониторинга указывают на необходимость проводить мониторирование длительностью более 24 часов и повторять его в случае выявления АВГП.

Ключевые слова: амбулаторный мониторинг артериального давления, частоты сердечных сокращений, вариабельность сосудистых расстройств.