A CASE OF MILD HYPERTENSION

WHAT CAN WE LEARN FROM OVER 900 DAYS OF DATA RECORDS?

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Abstract: Over 900 days of data records for blood pressure (systolic, diastolic) and heart rate for a single subject with mild hypertension were analyzed. From the data the Mean Arterial Pressure (MAP) was calculated. Linear regression over the entire time revealed a slight trend to higher MAP and lower heart rates. A clear circadian behaviour and a difference between work days (Mon-Fri) and weekends for the MAP data was detected.

Keywords: Hypertension, Mean Arterial Pressure, Heart Rate, Weekly and Circadian Variations.

Introduction

Hypertension or high blood pressure is a chronic medical condition in which the blood pressure in the arteries is elevated. This requires the heart to work harder than normal to circulate blood through the blood vessels. Blood pressure is summarised by two measurements, systolic and diastolic, which depend on whether the heart muscle is contracting (systole) or relaxed between beats (diastole). Normal blood pressure at rest is within the range of 100-140 mmHg systolic (top reading) and 60-90 mmHg diastolic (bottom reading). Mild hypertension is said to be present if it is persistently at or above 140/90 mmHg. This is the case in our data. In the diagnosis of hypertension the blood pressure is measured for a few days. With the availability of 24-hour ambulatory blood pressure monitors the possible circadian changes in pressure can be detected and wrong diagnosis avoided. Still, the question remains whether the 24-hour variation of the blood pressure is caused by sleep or is based on an internal controlled process. There are controversial statements about it in reference [1, 2]. No measurements were taken during sleep. Is there a 24-hour blood pressure variation detectable in our data?

There are practical no long-term data records of blood pressure and heart rate in the scientific literature. The here presented data analysis for Mean Arterial Pressure (MAP) and Heart Rate (HR) is a first tiny step to fill this gap. Furthermore, in the most published studies [2, 3] data are measured under strict controlled conditions in a hospital environment. But, what happens to people with hypertension outside the controlled conditions? The long-term impact of everyday life with work and family stress on MAP and HR should be an import topic in biomedical research and will contribute to a better understanding of hypertension.

Methods

Data were recorded from a 54 year old female using an automatic wrist-based blood pressure monitor “SBC23” for more than 900 days. The date, clock time, systolic and diastolic blood pressure, and heart rate were stored in an excel file. In addition, the labels ‘medication (yes/no) and ‘work days’ or ‘vacation days’ were assigned to the data records. Measurements took place several times during the day, with some higher occurrence in the morning and in the evening.

From the Systolic Pressure (SP) and Diastolic Pressure (DP) the Mean Arterial Pressure (MAP) was calculated using equation (1).

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MAP = \frac{2 \times DP + SP}{3}
\]

All data points of MAP (mmHg) and HR (beats per minute) together with overall means and linear regressions are displayed in figure 1 as function of date and clock time. The variation of MAP and HR over the course of the day is shown in figure 2 using a nonlinear regression of higher order. The impact of work days

Figure 1: Mean Arterial Pressure (MAP) and Heart Rate (HR) as function of recorded day. Vertical yellow lines mean blood pressure medication was taken; lower green dots display vacation days.
compared to free days on MAP and HR is presented in
figure 3. The different perspective of the data analysis
using these selected time scales give a really good
overview about the development of the hypertension
of our single subject.

Results
The overall average of the MAP data is 103 mmHg and of
the HR data is 74 beats per minute (figure 1). According
to the blood pressure categorization used in [1] indicates
the MAP value a mild case of hypertension. The trend
over the recorded time scale is increasing despite the
more frequent intake of blood pressure medication. It is
interesting to notice that the MAP average on vacation
days is reduced to 101 mmHg whereas the HR stays the
same. In addition, a negative correlation between MAP
and HR of -0.18 was detected. This correlation is
significant (*).

Data records are available between 04:00 and 23:00
during wake times of the subject. The distribution of
MAP and HR during these clock times are displayed in
figure 2. A nonlinear regression of the 7th order shows
two maxima for the MAP data, the first one between
05:00 and 06:00 in the morning and a second one around
20:00 in the evening. The average MAP value during
noon times is below the critical threshold of hypertension.
The same regression yields for the HR a different time
course with only one maximum around 07:00. A possible
impact of daily work is presented in figure 3. During the
normal work week (Mon-Fri), the average MAP value
indicates a case of mild hypertension. On weekends,
especially on Saturday our subject moves to the MAP
category “normal”. There is no difference between work
week and weekend for the HR data.

Discussion
The data used in our investigation are from a single
subject and were measured under everyday conditions
with quite primitive equipment. Even under these
circumstances, we demonstrated that long-term blood
pressure and heart rate recordings are showing a
remarkable depth of information. Overall the Mean
Arterial Pressure is the more sensitive parameter
compared to Heart Rate. General trends about the
improvement or deterioration of the subject’s health state
can be recognized. Lower average HR seems to be linked
to higher average MAP. The findings about this
relationship in [2] point to the opposite.

Another contradiction to the results in [2] was found
regarding the 24-hour MAP variation. Our data show
clear 24 hour and 12 hour periodic behaviour. These
results are supported by the detailed discussion of the
timing for the blood pressure in [4]. The state of mild
hypertension of our subject seems mostly driven by work
related issues. During vacation and on weekends the
average MAP value is decreased, crossing the threshold to
normal blood pressure values. Additional information
about our subject would clearly reveal the main cause of
the hypertension. From personal interviews it became
obvious that a substantial differences in average sleep
duration between work days and free days exist. It is well
known that chronic sleep deprivation could be one
possible cause of hypertension. More of these studies with
more subjects are needed to test the general validity of
our results especially regarding the 24 hour and 12 hour
periodic variations of the MAP data.

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