SHORT COMMUNICATION

Ambulant blood pressure: reproducibility and the assessment of interventions

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Summary

1. We have assessed the day-to-day reproducibility of intra-arterial blood pressure by monitoring 17 freely ambulant hypertensive patients for a period of 48 h. Eight had no change of therapeutic regimen throughout and nine took a single dose of a hypotensive agent before retiring on the second night.

2. Records were analysed to provide hourly mean values of heart rate, systolic and diastolic blood pressure. No significant differences between first and second day recordings were found except after the intervention in the second group.

3. Allowing subjects to follow their normal daily routine produces inevitable variation in their pattern of physical and other activity. However, by the use of these methods of recording and analysis, with pooled measurements from a small group of subjects, reproducibility is sufficiently good to permit the reliable assessment of therapeutic interventions.

Key words: ambulatory monitoring, blood pressure, indoramin, reproducibility.

Introduction

Ambulatory monitoring of blood pressure by various methods is becoming popular as a tool in the investigation of the effects of physiological and pharmacological factors. The great variability of casual blood pressure recordings, despite attempts to standardize conditions, and the inaccuracy of non-invasive measuring equipment makes this a desirable development. We have continued the use and development of a system (Bevan, Honour & Stott, 1966) which allows the wearing of a portable device continuously recording intra-arterial blood pressure. The established safety of the technique has encouraged us to make recordings regularly on subjects who engage in their normal daily routine, thus achieving an accurate assessment of blood pressures in the normal, minimally disturbed environment. It has been suggested that recordings taken in this way are not suitable for the study of therapeutic interventions on blood pressure because they cannot be accurately reproduced (Rowlands, Stallard, Watson & Littler, 1980). Previous observations (Raftery & Millar Craig, 1979) have suggested that constructing a circadian curve from hourly mean pressures and heart rates smooths over the individual fluctuations to produce a highly reproducible curve, which accurately describes blood pressure variation in groups of subjects. We have now analysed data from a substantial number of subjects in order to test this hypothesis and present here the results of two studies designed to assess day-to-day reproducibility of this form of recording and analysis.
Patients and methods

Patients

Seventeen patients with uncomplicated hypertension were recruited for study from the hypertension clinic and were divided into two groups. Group 1 comprised eight patients (mean age 52 years, range 33–64 years), three who were untreated and five who were taking various β-adrenoreceptor-blocking agents. Treatment had been unchanged for at least 6 weeks before the study and was continued throughout. Group 2 consisted of nine patients (mean age 48 years, range 29–60 years), who were all previously untreated and took a single dose of an α-adrenoreceptor-blocking agent (indoramin, 100 mg) on retiring for the second night of the study only. (The intention was to study the effects of α-receptor blockade on nocturnal blood pressure trends.)

Recording commenced between 09.00 and 11.00 hours and continued for 48 h. After initial cannulation five subjects in group 1 and eight in group 2 underwent a short period of programmed exercise, which included a symptom-limited bicycle exercise test (mean duration 11 min). The remaining subject in group 2 underwent his exercise programme on the second morning of the study. Apart from this period all subjects followed their normal daily routine at work and sleeping at home. Brief visits to the hospital were necessary each morning and evening for servicing of the monitoring equipment. No instructions about physical activity were given to the subjects other than to follow their normal routine as far as possible.

Recording and analysis

Monitoring equipment and methods have been described in detail elsewhere (Miller Craig, Bishop & Raftery, 1978; Millar Craig, Hawes & Whittington, 1978). Briefly, a cannula was inserted percutaneously into the non-dominant brachial artery of the subject. A portable transducer–perfusion unit was attached by manometer tubing and signals from the transducer and from electrocardiographic chest electrodes were recorded on two channels of cassette tape by a portable recorder (Medilog, Oxford Medical Systems).

After editing out periods of dubious signal quality the beat-by-beat blood pressure signal was processed by a hybrid computer system (Cashman, Millar Craig & Stott, 1979) to reduce the data to hourly mean values of pulse interval time (converted and expressed as heart rate), systolic and diastolic pressure. The hourly values, standardized by clock time, were compiled according to group and day of study. The differences between days 1 and 2 were assessed by Student’s t-test for paired observations.

Results

Plots joining hourly mean values of heart rate, systolic and diastolic pressure are shown for groups 1 and 2 (Fig. 1). In each case the results from days 1 and 2 are displayed separately. In group 1 no mean value during day 2 was different by a statistically significant margin from its corresponding value on day 1. In group 2 there were no significantly different values until after the time when the α-receptor-blocking agent was taken. Thereafter the plots of blood pressure clearly diverged and significant differences emerged, the plots merging again towards the end of the study. Full comparative results for group 2 were not available until midday; results before this have been omitted. Heart rate was clearly similar throughout the 24 h. Although a decrease in blood pressure was evident in the 5 h after indoramin therapy no effect was observed on the rising trends in the early morning. This was consistent with the known pharmacokinetics of the drug, the mean plasma half-life being 5.5 h (Draffan, Lewis, Firmin, Jordan & Dollery, 1976).

Discussion

Subjects given the freedom to pursue their normal daily routine will inevitably only loosely follow the same pattern of activity from one day to the next. The invasive nature of the method precludes repeated control studies in patients who are participating in pharmacological and other trials. Since the value of such studies depends on the reproducibility of the results we have sought to assess this during single prolonged recordings.

The results from group 1 show a high degree of day-to-day reproducibility. Systolic pressure tended to be higher in the first few hours of day 1 and this may reflect the period of exercise or a period of mental adjustment to the monitoring procedure. The complete absence of any statistically significant differences here or elsewhere in the study confirms that the short-term reproducibility of the technique is high. This contrasts with the study of Kain, Hinman & Sokolow (1964), where the use of a portable non-invasive measuring device showed higher pressures on day 1 than the lower but similar pressures recorded during days 2 and 3 of
Reproducibility of ambulant blood pressure

FIG. 1. Circadian plots of heart rate, systolic and diastolic pressure during day 1 (●—●) and day 2 (○—○) of a 48 h study of freely ambulant individuals. (a) Results from eight subjects whose therapy remained unchanged; (b) results from nine subjects whose sole therapy was indoramin (100 mg) at 23.00 hours on day 2. ●—●, P < 0.05; ○—○, P < 0.01; ○—○, P < 0.001).

Ambulatory study. It should be noted that the laws of probability would allow three or four significantly different points (P < 0.05) due to chance alone in 72 different comparisons. The results from group 2 again highlight the reproducibility of the method and also the clear effect of a standardized intervention.

Physical activity undoubtedly influences blood pressures in the short term and, not surprisingly, if it is purposefully manipulated during the course of an ambulatory study, significant differences can be demonstrated. Rowlands et al. (1980) studied six patients over 48 h and found significant differences between the mean blood pressure values during a 4 h period randomly allocated to rest or activity. We have also reported a small reduction in hourly mean values during the daytime when subjects were confined to bed (Mann, Millar Craig, Melville, Balasubramanian & Raftery, 1979), although there were also some apparently delayed effects. However, when free ambulation is prescribed, as in the methods employed in this study, it appears that the effect of individual variation in activity is essentially random and still allows valid assessment of drug interventions. We feel that this is of fundamental importance in ambulatory monitoring, the goal of which must be to monitor physiological variables during as normal a lifestyle as can be achieved. It would also appear that useful results can be obtained with relatively small numbers of subjects, although most of our current clinical trials involve larger groups. No assessment has yet been reported of the longer-term reproducibility of this technique, although from the results presented here we feel that this is also probably good.

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References


