Alerting Reaction and Rise in Blood Pressure During Measurement by Physician and Nurse

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SUMMARY Blood pressure was monitored by a continuous intra-arterial recording in 46 subjects to investigate whether the alarm reaction and the blood pressure and heart rate increases that occur during cuff blood pressure measurement made by a physician 1) attenuate when the physician's visit is repeated several times and 2) are less pronounced if a nurse measures the blood pressure. In 16 subjects the peak mean blood pressure and heart rate rises that occurred in the early part of the physician's first visit (22.6 ± 1.8 mm Hg and 17.7 ± 1.7 beats/min) were virtually identical to those occurring during three subsequent visits by the same physician throughout a 2-day intra-arterial blood pressure monitoring. The less pronounced pressor and tachycardic responses observed in the last part of the physician's visit also were virtually identical among the four visits. In contrast, in 30 other subjects the blood pressure and heart rate rises that occurred during the nurse's visit were 46.7% and 42.1% less (p<0.01) than those occurring during the physician's visit. The late and less pronounced pressor and tachycardic responses to the visit were also significantly less (p<0.01) in the former than in the latter condition. These results indicate that the error of overestimation of blood pressure inherent in cuff blood pressure measurement by a physician cannot be avoided by repeated visits by the physician over a short time span. It clearly can be reduced, however, if blood pressure measurements are performed by a nurse. (Hypertension 9: 209-215, 1987)

KEY WORDS alerting reaction • invasive blood pressure monitoring • hypertension • blood pressure • stress

We have previously shown that blood pressure measurements made by a physician may trigger an alerting reaction that is responsible for a rise in blood pressure that lasts several minutes. As hypertension usually is defined in terms of the blood pressure level measured by the physician, this rise can lead to a misdiagnosis of hypertension, particularly of so-called mild hypertension, and to incorrect decisions about when and how much to treat. It is therefore clinically important to investigate the conditions in which the alerting reaction and the accompanying blood pressure rise can be reduced or abolished.

In the present study we directed our attention to two possibilities that have been widely discussed but not tested experimentally: 1) The blood pressure increase induced by the physician's visit may decline when the visit is repeated several times, and 2) its magnitude may be less marked if the visit is made by a nurse than by a physician. As in previous studies this investigation was performed in subjects undergoing prolonged intra-arterial blood pressure monitoring to allow the values before and at the various times during the physician's and the nurse's visits to be accurately assessed.

Subjects and Methods
We studied 46 hospital inpatients, all of whom gave informed consent. The subjects were either normotensive or had mild or moderate essential hypertension with no sign of severe target organ damage. No hypertensive subject received antihypertensive treatment from 2 weeks before admission until the end of the study.

After 5 to 7 days in the hospital, all subjects underwent intra-arterial blood pressure monitoring by the Oxford technique. A catheter was implanted in a
radial artery after local anesthesia with 2% lidocaine. The catheter was connected by a rigid polyethylene tubing to a Plexiglas box fastened to the subject’s thorax at the level of the heart. The box contained a 40-ml saline reservoir pump unit (battery-operated) that provided the catheter with a constant, slow perfusion to keep it patent throughout the recording. The box also contained a blood pressure transducer connected to an amplifier and a battery-operated mini-tape recorder (fastened to the subject’s waist) on which the signals were stored. The stability of the zero signal, the linearity of the transducer, and the adequacy of the frequency response curve of the tubing-amplifying-storing system were checked before and after the recording period to ensure the reliability of the recorded signal. No subject complained of pain or discomfort as a result of the procedure adopted.

In 6 normotensive and 10 hypertensive subjects of either sex (11 men, 5 women) and of various ages (mean, 37.6 ± 11.7 years; range, 19–61 years), the recording began in the early afternoon and continued without interruption until late evening of the following day. During the recording the subjects were free to move within the hospital area and to engage in the usual social activities of hospital inpatients. They were asked to stay in bed for 30 to 40 minutes on the first evening after the beginning of the recording, and for 30 to 40 minutes in the morning, afternoon, and evening of the following day, so that four routine blood pressure assessments, with a sphygmomanometer applied to the uncatheterized arm, could be performed. These assessments consisted of three measurements taken at the 2nd, 5th, and 8th minute of a 10-minute visit by a male physician other than the one directly in charge of the subject’s care. The same physician was appointed for all four assessments. The time and the duration of the visits could be identified by the use of an event marker on the patient’s recording tape.

In another group of 10 normotensive and 20 hypertensive subjects of either sex (18 men, 12 women) and of various ages (mean, 46.2 ± 11.8 years; range, 16–64 years), the recording began in the late evening and continued without interruption for 24 hours. These subjects, who were also free to engage in the ambulatory and social activities of hospital inpatients, were asked to stay in bed for 30 to 40 minutes on the first evening after the beginning of the recording, and for 30 to 40 minutes in the morning, afternoon, and evening of the following day. As described previously,1 the three actual mechanical cuff inflations performed by the physician caused no significant differences in the amount of rise. No subject complained of pain or discomfort as a result of the procedure adopted.

After completion of the intra-arterial recording, the blood pressure signals recorded before, during, and after the visits were displayed on an ink-writing polygraph. The data for systolic and diastolic pressure were calculated by averaging the values obtained over 10-second periods sampled every 2 minutes for the 10 minutes immediately before the visit, the 10-minute visit, and the 10 minutes immediately after the visit. A similar analysis was performed for mean arterial pressure, calculated by electronic damping of the pulsatile pressure signal, and heart rate, calculated from a tachograph triggered by the systolic pressure wave.

Peak or maximum values measured during the visit were compared with a reference value taken at the fixed interval of 4 minutes before the beginning of the visit. Values measured at the 5th and 10th minute of the visit were also compared with the values 4 minutes before the visit. For the group as a whole, these comparisons were evaluated statistically by the t test for paired observations. This test was also employed for comparing the results obtained during the physician’s and the nurse’s visits, while the results obtained during the physician’s four visits were compared by two-way analysis of variance.6 A p value less than 0.05 was taken to indicate statistical significance. Throughout the text values refer to mean ± SEM.

Results
Effects of Repeated Visits by the Physician

In agreement with previous reports,1 during the physician’s visit the subjects showed a rise in systolic and diastolic blood pressures and heart rate that began as soon as the physician arrived and reached a maximum between the 2nd and the 4th minute. As shown in Figure 1, these peak responses, although widely different among subjects, were on the average significant and large. Furthermore, the average peak rises were similar among different visits, with no attenuation from the first to the fourth one.

The similarity between the peak blood pressure and heart rate rises occurring during the physician’s four visits is shown in Figure 2. In addition, Figure 2 shows that the amount of rise declined rapidly during the remainder of the visit, although as far as systolic and mean arterial pressures were concerned, the pressures always remained significantly higher than those before the visit, even after 10 minutes. The average rise in blood pressures and heart rate observed at the 10th minute of the physician’s visit was about one third of the peak rise, and no significant difference in the amount of increase was found among the four visits. As described previously,1 the three actual mechanical cuff inflations performed by the physician caused no additional blood pressure and heart rate changes during any of the four visits.

Comparative Effects of Physician’s and Nurse’s Visits

With only a few exceptions (four male and three female subjects), during the nurse’s visit the subjects showed less pronounced peak rises in systolic blood
pressure, diastolic blood pressure, and heart rate than during the physician’s visit (Figure 3). The average rises were, respectively, 44.2%, 50.4%, and 42.1% less during the nurse’s than during the physician’s visit; all differences were statistically significant. An example in which these differences were particularly evident is shown in Figure 4.

Figure 5 shows that the blood pressure and heart rate
FIGURE 3. Maximum rise in SBP, DBP, and HR occurring in 30 hospitalized subjects during a physician's and a nurse's visits. Data are expressed as change from a control value taken 4 minutes before each visit. Abbreviations as in Figure 1.

FIGURE 4. Original tracing from one subject of continuous intra-arterial blood pressure and heart rate (HR) while a nurse (upper panel) or a physician (lower panel) was at the bedside and measured blood pressure by the cuff method. Arrows indicate the beginning and the end of the visit. ABP = pulsatile arterial blood pressure; MBP = mean arterial pressure.
effects of the nurse’s visit rapidly declined and that, at the 5th and 10th minutes of the visit, they remained significantly smaller than those induced in the same subject by the physician’s visit. Furthermore, the blood pressure values at the 5th and 10th minutes of the physician’s visit, though declining, were still significantly higher than the reference values before the visit, whereas the blood pressure values at the same times during the nurse’s visit were no longer significantly different from their reference values.

During the physician’s first visit, the peak rises in mean arterial pressure and heart rate were 17.7 ± 1.6 mm Hg and 15.4 ± 1.3 beats/min in the male subjects (n = 29) and 18.6 ± 2.4 mm Hg and 13.9 ± 2.1 beats/min in the female subjects (n = 17). During the nurse’s visit, the peak mean arterial pressure and heart rate rises were 8.1 ± 1.6 mm Hg and 8.0 ± 2.1 beats/min in the male subjects (n = 18) and 9.1 ± 2.9 mm Hg and 7.3 ± 2.0 beats/min in the female subjects (n = 12). Thus, no significant difference in the peak responses were observed as a function of the subjects’ sex. This was also true for the late visit–dependent responses.

Comparative Effects of Physician’s and Nurse’s Visit and Patients’ Blood Pressure and Age

As shown in Table 1, in the 46 subjects the peak and late hemodynamic effects of the physician’s visit did not show any correlation with the patients’ 24-hour mean arterial pressure and age. This was also true when the hemodynamic effects of the nurse’s rather than the physician’s visit were correlated with patients’ 24-hour mean arterial pressure and age (n = 30).

Discussion

This study confirms previous observations of our group¹ that cuff blood pressure assessments made by a physician who is unfamiliar to a patient are associated

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**FIGURE 5.** Comparison of maximum (or peak) rises in SBP, DBP, MAP, and HR occurring in the same 30 subjects as in Figure 3 during a physician’s and a nurse’s visits. The rises occurring at the 5th and 10th minutes of the visits are shown. Data are expressed as mean (± SEM) changes from a control value taken 4 minutes before each visit. Abbreviations as in Figure 1.
with an early blood pressure and heart rate rise whose magnitude and intersubject variability is independent of the patient’s baseline blood pressure and age. It also demonstrates that these pressure and heart rate responses were similar when the same physician repeated the assessment on four different occasions on 2 consecutive days. Thus, the alerting reaction that patients experience the first time they are visited by a physician responsible for measuring their blood pressure does not attenuate as the physician’s unfamiliarity is reduced by repeated visits over a short time.

Does this mean that there is no way to reduce the alerting reaction and the pressor response triggered by blood pressure measurements made by a physician, and that, therefore, overestimation of patients’ blood pressure by this procedure, the so-called white coat hypertension, is largely unavoidable? Our study cannot definitely lead to such a conclusion because we cannot exclude the possibility than an attenuation of the alerting reaction and the pressor response to the physician’s visit may occur over a greater number of visits or a longer time span than was imposed by the invasive nature of our observations. This possibility may be supported by 1) the observation that blood pressure values obtained by the traditional sphygmomanometer tend to decrease when measurements are performed repeatedly over prolonged time intervals and 2) the results of the Australian trial on mild hypertension, in which a large proportion of subjects on placebo were shown to normalize their blood pressure over a few months. However, the lack of information regarding the previsit blood pressure values (and therefore the inability to examine the blood pressure responses to the visit) limits the importance of these findings. Furthermore, in the Australian trial, a blood pressure reduction resulting from the psychological impact of the placebo treatment cannot be excluded. The possibility of a long-term attenuation of the alerting reaction and the blood pressure rise induced by the physician’s visit therefore remains a matter for investigation.

Regardless of how they are attenuated, the early pressor and tachycardic responses occurring during cuff blood pressure assessments were, with only a few exceptions, less pronounced when the procedure was performed by a nurse rather than by a physician; the average reduction amounted to 45.2% and 42.1% of the peak mean arterial pressure and heart rate rises, respectively. Because our study used a male doctor and a female nurse (a protocol dictated by the prevailing gender of our hospital staff; see Methods), this difference might have originated from the fact that a woman triggered a less intense alerting reaction than a man. However, this possibility is made less likely by the fact that the blood pressure and heart rate responses to the physician or the nurse were not significantly different in the male and the female patients, a finding against the substantial importance of a sex interaction factor. An alternative possibility is that the more pronounced hemodynamic response to the physician’s as compared with the nurse’s visit originated from the fact that, regardless of their sex, physicians have a greater emotional implication for patients than nurses, whose presence does not normally forecast immediate diagnostic and therapeutic decisions. It should be emphasized, however, that, although less pronounced, the pressor responses induced by the nurse were by no means trivial and that the blood pressure increase brought about by this measurement (average change in mean arterial pressure, + 8.5 mm Hg) is still sufficient for overestimation of blood pressure in a large number of patients. In this regard, a better way to proceed appears to be performance of multiple blood pressure measurements and selection of the value obtained 10 minutes after the beginning of the physician’s or the nurse’s visit, because of the rapid decline of the early peak rises that occurred with either visit. With this method, a nurse may be able to obtain blood pressure values similar to those existing before the visit, thus avoiding the error of overestimation of blood pressure associated with blood pressure measurements by physicians.

A final point that needs to be considered is whether blood pressure values obtained largely or totally in the absence of an emotional pressor response provide a better index for the clinical evaluation of hypertension. So far there is solid epidemiological evidence that casual, physician-obtained blood pressure bears a significant relationship to the development of cardiovascular morbidity and mortality. This information is not available for blood pressures that are obtained partially or totally free from the effects of the alerting reaction. However, in a study performed many years ago, Smirk and Alam reported that the lowest blood pressure measurable during a prolonged visit (the “basal” blood pressure) correlates better than the initial one with the complications of hypertension. Furthermore, recent cross-sectional studies have suggested that 24-hour or daytime mean blood pressure relates to the target organ damage of hypertension more closely than the higher blood pressure obtained by casual measurements. The superiority of daytime over casual blood pressure also has been demonstrated prospectively in one study. Although more evidence is needed, these results suggest that reduction or avoidance of the blood pressure overestimation inherent in the traditional procedures for measuring blood pressure may indeed be of clinical value.

| TABLE 1. Relationship Between the Hemodynamic Effects of the Physician’s Visit and the Age and Blood Pressure of 46 Patients |
|------------------------|-----------------|-----------------|-----------------|------------------|
| MAP rise (mm Hg)       | HR rise (beats/min) |
| Peak      | Late  | Peak      | Late  |
| 24-hr MAP (mm Hg)     | 0.06  | 0.14  | 0.10  | 0.22  |
| Age (yr)   | 0.20  | 0.24  | 0.28  | 0.24  |

Data represent correlation coefficients between the peak and 10-minute (late) mean arterial pressure (MAP) or heart rate (HR) rises observed during the physician’s visit and the age or 24-hour average MAP in the 30 subjects of the first and the 16 subjects of the second series. Data from the first visit were considered for the 16 subjects of the second series. Note that no coefficient was statistically significant.
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Alerting reaction and rise in blood pressure during measurement by physician and nurse.
G Mancia, G Parati, G Pomidossi, G Grassi, R Casadei and A Zanchetti

doi: 10.1161/01.HYP.9.2.209

*Hypertension* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0194-911X. Online ISSN: 1524-4563

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