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ORIGINAL ARTICLE

Influence of the presence of doctors-in-training on the blood pressure of patients: a randomised controlled trial in 22 teaching practices

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Until now, no information is available about the effect of the presence of a doctor-in-training on a patient's blood pressure. We tested the hypothesis that the presence of a last year medical student might increase the blood pressure of the patient, in addition to the possible pressor response to the doctor-trainer. Normotensive and hypertensive patients with a minimum age of 25 years, visiting for any reason, were recruited at 22 teaching general practices. Patients were randomised into a 'trainee' group ($n=133$) and a 'no trainee' ($n=129$) group. The blood pressure was measured at two subsequent contacts. In the 'trainee' group, a student was present at the first visit only. In the 'no trainee' group, both visits were without student. Both groups had similar anthropometric characteristics at entry. At the first visit, systolic pressure was higher in the 'trainee' group than in the control group (139.5 *vs* 133.1 mmHg, $P=0.004$), with a similar trend for diastolic pressure (80.2 *vs* 77.8 mmHg, $P=0.07$). From the first contact to the follow-up visit, blood pressure decreased in the trainee group by 4.8 mmHg systolic ($P<0.001$) and 1.7 mmHg diastolic ($P=0.03$), whereas the corresponding changes in the control group were −0.1 mmHg ($P=0.90$) and +1.5 mmHg ($P=0.03$). Thus, the between group differences in these trends averaging 4.7 mmHg (CI 1.5–7.9, $P=0.005$) systolic and 3.2 mmHg (CI 1.1–5.3, $P=0.003$) diastolic were statistically significant. We conclude that in teaching-practices, the presence of a doctor-in-training has a significant pressor effect when an experienced general practitioner measures a patient's blood pressure. If confirmed, our findings imply that doctors should be cautious to initiate or adjust antihypertensive treatment when blood pressure readings are obtained in the presence of a student.
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Introduction

Medical students (henceforth named trainees) are often present when patients visit a doctor or a clinic. Although most patients accept that doctors in training must develop their clinical skills, the presence of a student might add to the arousal that the medical environment already imposes on a patient. This could lead to a substantial increase in blood pressure, as suggested by casual observations in our own general practice.

Numerous publications already addressed the 'white-coat' effect, that is, the transient rise in a patient's blood pressure when measured by an observer in a medical environment.[1–7] However, to the best of our knowledge, no published report investigated whether a doctor-in-training when present is a neutral bystander or an obtrusive observer provoking a reactive increase in a patient's blood pressure. The relevance of this research question is underscored by the fact that treatment of hypertension is a frequent reason to consult primary care physicians.[2] We therefore undertook a

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randomised clinical trial to evaluate to what extent the presence of a medical student might influence a patient's blood pressure when it is measured by an experienced practitioner.

Methods

Doctors and patients

A total of 22 general practitioners affiliated with the University of Ghent (Belgium) as trainers of medical students, agreed to enrol at least 10 patients visiting for any reason between March 2001 and June 2001 and to re-examine these patients at a subsequent occasion.[8] Patients were eligible if they were 25 years or older, and if they were registered at the practice for at least 1 year. We excluded patients with an acute medical condition, recent surgery, severe chronic disorders, secondary hypertension, or pregnancy. We also did not consider patients with recent psychological or social problems.

Study protocol

In all, 281 consecutive patients complied with the entry criteria and were randomly assigned to a 'trainee' or 'no trainee' group. Randomisation was balanced within practices, with five patients allocated to each of the 'trainee' and the 'no trainee' groups. To randomise a patient, the practitioner drew a lot from an opaque envelope. Sample size calculation assuming a standard deviation of systolic pressure of 15 mmHg demonstrated that 131 patients per group might be needed to reveal a between-group difference of 6 mmHg on a two-sided test with the α-level and power set at 5 and 90% respectively.[9] The blood pressure of all patients was measured by the experienced doctor-trainer at baseline and at the follow-up visit approximately 2 months later. In the 'trainee' group, the first blood pressure measurement took place in the presence of the trainee.

Blood pressure measurement

Before the study, all investigators were trained to measure blood pressure according to the WHO-NHG guidelines.[10–19] After the patients had rested for 5 min in the sitting position, doctors obtained one reading of systolic and diastolic (phase V) blood pressure. The patients refrained from smoking and caffeinated beverages for at least 20 min before the blood pressure was recorded. Within practices, doctors used the same mercury sphygmomanometer for all patients. The sphygmomanometers were used as calibrated for usual practice. No special calibration was carried out for this specific study. Hypertension was defined as a blood pressure of at least 140 mmHg systolic or 90 mmHg diastolic. Hypertensive patients whose treatment changed during follow-up were excluded from the analysis.

Statistical analysis

For database management and statistical analysis, we used the SPSS Inc., version 10. We compared means of normally distributed data by Student's *t*-test for paired or unpaired observations, as appropriate. Medians were compared by Wilcoxon's signed rank test and proportions by a χ^2 statistic.

We searched for correlates of the blood pressure changes from the first to the second visit. Using stepwise linear regression, we considered as potential explanatory variables: trainee *vs* no trainee group; gender of patient, doctor and trainee (separate analysis for 'trainee' group); patient characteristics including age, initial blood pressure, smoking status, history of diabetes and cardiovascular diseases, overweight (body mass index $\geqslant 27\,kg/m^2$), and hypercholesterolaemia (serum total cholesterol $\geqslant 240$ mg/dl); and the interval between the two visits.

Results

Characteristics of doctors and patients

Of the 281 randomised patients, 142 were in the 'trainee' group and 139 were in the 'no trainee' group (Figure 1). At randomisation, the two groups had similar anthropometric characteristics (Table 1). Of the 22 participating doctors, 18 were male and four were female. On average, they had 20.5 years of

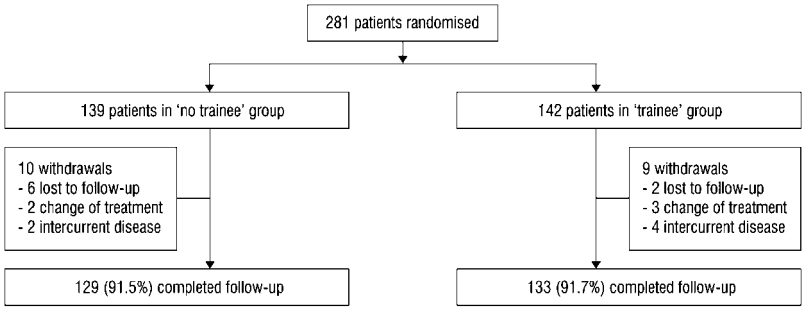

Figure 1 Flow of patients.

Table 1 Patient characteristics at randomisation

	'No trainee' group (n = *129)*	*'Trainee' group* (n = *133)*
Mean (s.d.) age (years)	63.0 (±15.4)	63.9 (±15.2)
Men (%)	42 (32.5)	48 (36.0)
Smokers (%)	25 (19.3)	19 (14.2)
Serum cholesterol ≥ 240 mg (%)	24 (18.6)	26 (19.5)
Body-mass index ≥ 27 kg/m^2 (%)	36 (27.9)	37 (27.8)
Diabetes mellitus (%)	12 (9.3)	10 (7.5)
Antihypertensive treatment (%)	67 (51.9)	66 (49.6)

All comparisons between 'no trainee' group and 'trainee' group were nonsignificant ($P > 0.18$).

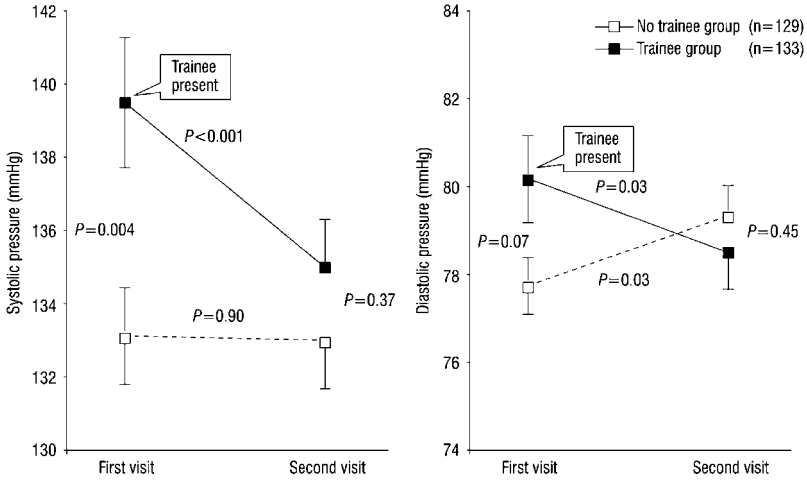

Figure 2 Systolic and diastolic blood pressure at baseline and follow-up by randomisation groups. Values are means ± s.e.

practice and had previously trained 17.5 students. Of the 27 doctor-students, 21 were female.

Trainee effect

At the first visit (Figure 2, and Table 2), systolic pressure was 6.4 mmHg (CI 2.0–10.8 mmHg, $P = 0.004$) higher in the 'trainee' than in the control group (139.5 ± 20.5 (s.d.) mmHg *vs* 133.1 ± 15.0 mmHg), with a similar trend (+2.4 mmHg, CI −0.1 to 4.9 mmHg, $P = 0.07$) for diastolic pressure (80.2 ± 12.6 *vs* 77.8 ± 8.3 mmHg). Median follow-up was similar in the 'trainee' and 'no trainee' groups ($P = 0.23$), lasting 51.5 days (P25–P75 interval 35.0–61.5 days) and 48.1 (42.5–69.5) days, respectively. At the second visit, systolic and diastolic blood pressures were similar in the 'trainee' and 'no trainee' groups and averaged 134.7 ± 16.6/78.5 ± 9.8 mmHg and 133.0 ± 14.7/79.3 ± 8.3 mmHg, respectively ($0.37 < P < 0.45$). From randomisation to follow-up, blood pressure decreased in the 'trainee' group by 4.8 mmHg (CI 2.1–7.4 mmHg, $P < 0.001$) systolic and by 1.7 mmHg (CI 0.10–3.3 mmHg, $P = 0.03$) diastolic, whereas the corresponding changes in the control group were −0.1 mm (CI −1.8 to 2.0 mmHg, $P = 0.90$) and +1.5 mmHg (CI 0.1–2.8 mmHg, $P = 0.03$). Thus, the between-group differences in the blood pressure changes over time, averaging 4.7 mmHg (CI 1.5–7.9 mmHg, $P = 0.005$) systolic and 3.2 mmHg (CI 1.1–5.3 mmHg, $P = 0.003$) diastolic, were statistically significant.

Percentage of patients with elevated blood pressure

The percentage of patients on antihypertensive treatment was similar in the two randomisation groups (49.6 *vs* 51.9% in 'trainee' *vs* 'no-trainee' group, $P = 0.83$). (Table 1). At the first contact, 60.9% patients of the 'trainee' group had an elevated blood pressure (≥140/90 mmHg), compared with 47.3% at the second contact ($P = 0.02$). In the 'no trainee' group, the percentage of hypertensive patients was similar at both visits (42.6 *vs* 42.6%, $P = 0.99$) (Table 2). The percentage of hypertensive patients at the first visit was significantly higher in the 'trainee' group compared with the 'no trainee' group (60.9 *vs* 42.6%, $P = 0.003$), while there was no significant difference at the second visit (47.3 *vs* 42.6%, $P = 0.52$).

Covariables of trainee effect

Stepwise regression showed that systolic blood pressure at baseline (partial $R^2 = 0.35$; $P < 0.0001$)

Table 2 Blood pressure and percentage of hypertensive patients at baseline and follow-up by randomisation groups

	First visit	*Second visit*	P-*value between the two visits*
No trainee group (n = *129)*			
SBP mean (s.d.) (mmHg)	133.1 (±15.0)	133.0 (±14.7)	0.90
DBP mean (s.d.) (mmHg)	77.8 (±8.3)	79.3 (±8.3)	0.03
% of 'hypertensive' patients	42.6	42.6	0.99
Trainee group (n = *133)*			
SBP mean (s.d.) (mmHg)	139.5 (±20.5)	134.7 (±16.6)	<0.001
DBP mean (s.d.) (mmHg)	80.2 (±12.6)	78.5 (±9.8)	0.03
% of 'hypertensive' patients	60.9	47.3	0.02
P-value between trainee and no trainee group			
SBP	0.004	0.37	
DBP	0.07	0.45	
% of 'hypertensive' patients	0.003	0.52	

was the only significant determinant of the systolic trainee effect. Diastolic blood pressure at baseline (partial $R^2 = 0.36$; $P < 0.0001$) and randomisation group (partial $R^2 = 0.02$; $P = 0.02$) significantly contributed to the variability in the diastolic trainee effect.

Discussion

The main finding of our study was that in teaching-practices, the presence of a doctor-in-training had a significant pressor effect when an experienced general practitioner measured a patient's blood pressure. When considering the possible implications of these observations, a number of issues deserve discussion. These include the mechanisms that might explain our findings, and the possible clinical implications for teaching practices.

With regard to the mechanisms that might underlie our findings, anxiety and arousal are known to raise systolic blood pressure, often by as much as 30 mmHg.[1–7] This may be regarded as a physiological reaction, often referred to as the '*fight and flight*' phenomenon, or 'defence' or 'alarm' reaction. It is commonly observed in emergency departments of hospitals when patients are frightened, but as highlighted by our study, it may also occur in general practice. In our study, the between-group differences in systolic pressure at the initial contact averaged 6.4 mmHg systolic. Furthermore, in the trainee group systolic blood pressure decreased by 4.8 mmHg systolic from the first to the second contact. Presumably, the pressor effect observed in the presence of a doctor-in-training might be interpreted as a white-coat phenomenon, which may add to that already associated with blood pressure measurement by the doctor-trainer.

A *treatment effect* cannot explain the differences in blood pressure between the first and the second visit because the treatment remained unchanged in all patients and because the proportion of treated patients was similar in the 'trainee' and the 'no trainee' group.

Regression to the mean is unlikely to explain our observations, because patients were randomly assigned to groups and because at randomisation there were no significant differences between both groups, other than the measured blood pressure level. The 'trainee'-effect was greater on systolic than on diastolic blood pressure. The mean age of our patients was 63.5 years. In *older patients* with stiff arteries and attenuated baroreceptor reflexes, blood pressure raising stimuli are likely to have a greater effect on systolic than on diastolic blood pressure.[20–23] However, the present study must be interpreted within the context of its limitations. We cannot exclude that doctor-trainers might have been more accurate in their blood pressure reading in the *presence of a student* or more inaccurate when the student was not present.

The diagnosis, management and treatment of hypertension are critically dependent on the accurate measurement of blood pressure. If it is overestimated, it follows that incorrect decisions will be made. With over 20% of the adult population suffering from hypertension, and high blood pressure being a frequent reason to consult a primary care physician, the consequence of inaccurate blood pressure measurement carry implications for health care delivery. If confirmed, our findings imply that doctors should be cautious to initiate or adjust antihypertensive drug treatment when blood pressure readings are obtained in the presence of a trainee.

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