Abstract

Objectives: The aim of this study was to evaluate this two-step model for positive predictive value and number needed to screen.

Study design: In this observational clinical study 339 dental patients’ blood pressures were measured. Blood pressure ≥140 mmHg (systolic) and/or ≥90 mmHg (diastolic) performed home blood pressure acquisitions during one week. Those with an average home blood pressure ≥135 mmHg and/or ≥85 mmHg were referred to the Primary Health Care Centre, where three office blood pressure measurements were taken with one-week intervals.

Results: 249 patients were normotensive and 90 patients (27%) acquired home blood pressure measurements. After using the home blood pressure device, 52 (58%) patients had normal blood pressure, and 38 (42%) patients were referred to the Primary Health Care Centre. 28 patients were diagnosed as hypertensive, yielding a positive predictive value of 82% and a number needed to screen of 12.

Conclusions: This two-step model is applicable in dental screening, and has a high positive predictive value and a low number needed to screen.

INTRODUCTION

Hypertension (HT) is a global health problem with high prevalence today, despite reduced prevalence between the middle of the 70s to the beginning of the 90s [1]. Lim et al [2] concluded in 2010 that three major risk factors contribute to global disease burden, namely HT, smoking and alcohol abuse. Hypertension was ranked as the most important risk factor all over the world except for Oceania and sub-Saharan Africa. As non-treated HT increases the risk of developing cardiac failure and stroke, it is urgent to improve on early detection [3].

Since the Framingham study concluded that HT is a risk for coronary heart disease [4], screening for HT was initiated at dental schools. The dental profession was considered to play an important role in early detection of HT, as many patients are in contact with a dental team regularly. The prevalence of undetected HT varies between 5-34 % in studies performed during the last decades. These studies have been performed using various approaches, making direct comparisons challenging; mostly in dental schools, with different blood pressure (BP) limits for diagnosing HT, in different age groups, and in some studies the patients with elevated BP measured at one-point in time have been referred directly to the medical profession [5-12].

The “white coat effect” often increases BP (20-40%) when taken in a clinical setting compared with when the BP is acquired at home. As this condition affects approximately 30% of patients, it causes a large unnecessary workload for the healthcare system with many false positive high BP [13]. Home BP measurement solves the problem with the white coat effect and they have at least as good prognostic value for mortality and morbidity as office BP [14,15].

The aim of this study was therefore to find out the efficiency of a dental blood pressure screening complemented with home blood pressure in a two steps model.

MATERIALS AND METHODS

Study population

The study was performed between May 2010 and February 2013. Consecutives patients above the age of 40 years were invited to participate in connection to their regular check-up at the Public Dental Services, Varberg, Sweden. Exclusion criteria
were: known HT, atrial fibrillation, renal failure and pregnancy. At the appointment the patients received both verbal and written information and provided written consent before inclusion. The Regional Research Ethics Committee at the University of Lund (EPN 2009/204) approved the study, and it was performed in accordance with the Helsinki Declaration.

Procedure

The patient rested for at least 5 minutes in a quiet room before BP acquisition. Blood pressure was measured in a sitting position, twice in each upper arm using the Korotkoff-Riva-Rocci method, using a cuff, a calibrated manometer and a stethoscope. The equipment was validated at the Biomedical Engineering Department, Varberg, Sweden. Patients with an average systolic BP ≥140 mm Hg and/or an average diastolic BP ≥90 mm Hg were asked to use a home BP device (Omron M6 Comfort, Omron Healthcare Ltd, Kyoto, Japan) for one week [16]. The follow-up home BP measurements were acquired in the arm where the highest average BP was noted. The patient was given both verbal and written instructions on how to use the home BP device. The home BP was measured twice daily, at morning and evening, with 2 measurements acquired at each time point, with a few minutes between. The time of acquisition and BP were noted on an enclosed form. The form and home BP monitoring device were returned to the study team for calculating the average BP from day 2-7.

If the average home BP was systolic ≥135 mm Hg and/or diastolic ≥85 mm Hg, the patient was referred to his ordinary primary health care centre (PHCC) where 3 office BP measurements were acquired one week apart [17,18]. If the average office BP was systolic ≥140 mm Hg and/or diastolic ≥90 mm Hg the patient was diagnosed with HT, and the result was reported back to the study team.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics version 20. Descriptive statistics with mean, standard deviations, positive predictive value (PPV=number of patients with diagnosed hypertension/number of patients referred to the PHCC x 100, %) and number needed to screen (NNS=1/number of patients with diagnosed hypertension/number of examined patients) were used.

RESULTS AND DISCUSSION

Results

Descriptive statistics for the study group (n=339) are presented in Table 1, and an inclusion flow chart is shown in Figure 1. Normotensive patients (n=249) required no further examination. The remaining 90 patients (27%) showed an elevated BP at the Public Dental Services and thus measured home BP for one week. Thereafter, a further 52 (58%) patients showed a normal home BP, while 38 (42%) patients showed a high home BP. The latter group was referred to the PHCC. Four patients refused further examination and were considered as dropouts.

The systolic and diastolic BP distribution of the study groups in connection with the examination at the dental clinic, home BP monitoring, and the examination at the PHCC are shown in Table 2.

The examination at the PHCC resulted in 28 newly diagnosed patients with HT, yielding a PPV of 82% and a NNS of 12. Blood pressure results for this subgroup from the dental clinic, home measurements and from the PHCC are presented in Table 3.

The screening at the dental clinic resulted in 90 patients with an elevated BP, 52 (90%) of those 58 with a false positive value were identified by a normal home BP and thereby excluded from further examinations at the PHCC.

Discussion

The two-step screening model resulted in a PPV of 82% and it eliminated 90% of the false positive screened individuals, and thus reduced the number of patients referred to the PHCC. It is important that a screening method has a high sensitivity for keeping down the numbers of false negative, but it should also has a high specificity in order to reduce the numbers of false positive who creates an unnecessary workload for the health

<table>
<thead>
<tr>
<th>Table 1: Description of the whole study group, also divided into subgroups with high blood pressure (BP) at the dental clinic (DC) and those referred to the Primary Health Care Center (PHCC).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Whole study group (n=339)</strong></td>
</tr>
<tr>
<td>Mean age (SD)</td>
</tr>
<tr>
<td>Male/female (%)</td>
</tr>
<tr>
<td>Heredity for HT (%)</td>
</tr>
<tr>
<td>Mean BMI (SD)</td>
</tr>
<tr>
<td>BMI 25-30 (%)</td>
</tr>
<tr>
<td>BMI ≥30 (%)</td>
</tr>
<tr>
<td>Smokers (%)</td>
</tr>
<tr>
<td>Snuffusers (%)</td>
</tr>
<tr>
<td>Hyperlipidaemia (%)</td>
</tr>
<tr>
<td>Diabetes (%)</td>
</tr>
<tr>
<td>SD=standard deviation</td>
</tr>
</tbody>
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Hedström et al. (2015)
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Figure 1 Flow chart of the study population.

Table 2: Blood pressure (BP) among those measured: at the dental clinic (DC), at home and at the Primary Health Care Centre (PHCC).

<table>
<thead>
<tr>
<th></th>
<th>BP at the DC (n=339)</th>
<th>BP at home (n=90)</th>
<th>BP at the PHCC (n=34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SBP</td>
<td>DBP</td>
<td>SBP</td>
</tr>
<tr>
<td>Mean</td>
<td>122.5</td>
<td>79.3</td>
<td>130.1</td>
</tr>
<tr>
<td>SD</td>
<td>17.8</td>
<td>12.5</td>
<td>14.0</td>
</tr>
<tr>
<td>Range</td>
<td>90-220</td>
<td>45-130</td>
<td>103-169</td>
</tr>
</tbody>
</table>

Abbreviations: SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; SD: Standard Deviation

Table 3: Patients with newly diagnosed hypertension (n= 28) and their blood pressure (BP) values at the dental clinic (DC), at home and at the Public Health Care Center (PHCC).

<table>
<thead>
<tr>
<th></th>
<th>BP at the DC</th>
<th>BP at home</th>
<th>BP at the PHCC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SBP</td>
<td>DBP</td>
<td>SBP</td>
</tr>
<tr>
<td>Mean value</td>
<td>154</td>
<td>100</td>
<td>145</td>
</tr>
<tr>
<td>SD</td>
<td>24</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Range</td>
<td>120-220</td>
<td>80-130</td>
<td>117-169</td>
</tr>
</tbody>
</table>

Abbreviations: SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; SD: Standard Deviation

care system and lot of worries by the misclassified. By using a high cut-off value >160 systolic (13) or >95 diastolic (6) the number of false positive is reduced, this has been done in some comparable surveys and resulted in a PPV of 30% [12], and 96% [6]. The problem with a high cut-off value is that many with HT are classified as healthy. In the current study the international recommended cut-off values for HT diagnoses were used (≥140and/or ≥90 mm Hg), no other dental screening study has used these cut-off values. Close cut-off values have been used in formal surveys as ≥140 independent of diastolic value [18], >140 and/or >90 [8,9] resulting in a PPV range of 4-32%. By using the recommended cut-off values for HT diagnoses the result will be a large number of false positive because of the WCE and a low PPV. In the present study, a second screening step with home BP, followed the dental clinic BP and reduced the numbers of false positive with 90% and resulted in a PPV of 82%.

The design of the present study does not allow a sensitivity calculation because of the condition of masked HT (prevalence of 10-15%) which means those who have a normal office BP but a high home BP [17]. To get a true sensitivity value, BP of the whole study population should be measured both in the office and at home, but in the present study home BP was not measured among those who had a normal BP at the dental clinic.

In this current study was the BP at the PHCC the “golden standard” for diagnosis. The six patients who had a high BP at the dental clinic and a high home BP but a normal BP at the PHCC were regarded as false positive, but they could have had masked HT, which would have resulted in an even higher PPV.
The value of NNS is an effective measure of the screening method and depends largely on the proportion of non-diagnosed cases in the screening population, but also on the disease prevalence in the population, the sensitivity of the screening, the screening procedure and response rate. A NNS value of 12 as in the present survey is a low value, indicating an efficient screening.

The total drop-out frequency of 6% is uniquely low and a strength to this study; comparing surveys reported a drop-out frequency of 36-42% [9].

Another strength is the diagnostic procedure including two manually BP measurements on each arm after 5 minutes rest in the dental clinic, practical and written instructions how to use the validated home BP device, two morning and two evening home BP with one minute apart during one week, three office BP at the PHCC with one week apart. Those who finally got the HT diagnosis had had high BP measurements in all three locations: the dental clinic, home and in the PHCC.

This survey was performed in dental care, which annually or biannually sees a great majority of the general population, by using an existing organization for an opportunistic screening the cost could be limited.

A limitation of the two-step model is that the patient may use the automatic home blood-pressure device in an incorrect way or adjust the measured numbers to seemingly be healthy. Thus, good verbal and written information is essential, and trust between patient and dentist of utmost importance. Another limitation is that only one dental team with highly motivated personnel performed the survey.

CONCLUSION

The presented two-step screening model for early detection of hypertension has shown to be an effective way of reducing the imposition to the Primary Health Care Center sending patients not needed for examination. It also shown a high positive predictive value and a low number needed to screen. For investigate if this model is applicable in a greater extent, a multicentre study is planned including a larger patient population.

ACKNOWLEDGEMENTS

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REFERENCES