Title: Identifying patients with hypertension using ABPM

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Abstract:

The aim of this study was to assess the effectiveness of the systematic identification and sustained follow-up of hypertensive patients using ambulatory blood pressure monitoring (ABPM) within Phase III cardiac rehabilitation.

Methods: Patients with elevated BP (clinic measurement) on entry to cardiac rehabilitation had protocol cycles of ABPM, lifestyle education, medication changes and clinic BP monitoring, throughout cardiac rehabilitation and up to 6 months follow-up until BP control was achieved.

Results: Initial assessment using clinic measurement identified 30% (129) patients with uncontrolled hypertension. Only 38% (49) had hypertension as indicated by ABPM. These were followed up using protocol cycles up to six times. By the end 77% (99) of those originally identified as uncontrolled hypertension achieved control.

Conclusion: This systematic identification and sustained follow up of hypertensive patients using ABPM in cardiac rehabilitation was a convenient, successful method in identifying and controlling a significant amount of uncontrolled hypertension.

Keywords: hypertension, white coat hypertension, interventions, 24hour ambulatory blood pressure monitoring

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Introduction,

Hypertension is recognized as a major modifiable risk factor for cardiovascular disease (CVD) affecting 25-44% of adults, leading to a 75% increase in CVD mortality (Mancia et al. 2007, Gu et al. 2010, Perl et al. 2012, Perk et al. 2012,).

Although the diagnosis and treatment of hypertension has played a significant part in reducing mortality and morbidity rates of CVD, levels of BP control remain poor (Perl et al. 2012, Egan et al. 2011, Roark et al. 2011). Uncontrolled BP is seen in 40-80% of the so called treated hypertensive population (Perk et al. 2012). A range of interventions, from simple to complex have been developed to help improve control of hypertension. From a hospital basis these include, self-monitoring/management, medication changes, telephone follow-up, appointment reminders, telemonitoring, ambulatory blood pressure monitoring (ABPM), hypertension clinics or more multifaceted interventions. The degree of effectiveness of the different interventions varies greatly. A recent review suggested that overall nurse or pharmacist led interventions were effective and perhaps the way forward but warranted further evaluation (Glynn et al. 2010). Assessment within these interventions, usually takes the format of a detection and sustained follow up protocol (Magid et al. 2011, Glynn et al. 2010). Secondary prevention of modifiable risk factors is the core business of CR and although BP has been seen to improve following CR (Giannuzzi et al 2008), the evidence is scant (Chatziefstratiou et al 2013). CR contains many core tenets of behaviour change similar to the above qualities of good BP effective interventions. It can provide the opportunity and infrastructure to implement a more formal detection and sustained follow-up protocol that would be convenient to patients with little additional resource implications.

Routine use of ABPM is recommended for the diagnoses and management of hypertension, it has been shown to result in better control of BP and more rational prescribing for BP medications, greater cost effectiveness which could result in improved quality of life for the patient (Dolan et al. 2005, Perk et al. 2012).

The aim of this study was to determine the effectiveness of a systematic identification and sustained follow-up protocol in improving hypertension control superimposed upon usual care during Phase III cardiac rehabilitation.

Methods:

To evaluate the effectiveness of the protocol, this evaluative study used a quantitative approach, a longitudinal, non-experimental, descriptive research design and retrospective convenience sampling. The study was a naturalistic design, in which the protocol was superimposed onto current practice in CR which utilised standard guidelines for both CR including hypertension monitoring and control (Balady et al. 2007, Hevey et al. 2007, Mancia et al. 2007, Saner & Wood 2009, Piepoli et al. 2010, <http://www.nice.org.uk/CG127/guidance>),

Cardiac rehabilitation format

Eligible patients following a cardiac event such as myocardial infarction (MI), percutaneous coronary intervention (PCI), coronary artery bypass graft (CABG), valve surgery or angina were referred to Phase III CR. Haemodynamically unstable patients such as those with severe co-morbidities, unstable angina and unstable heart failure as defined by clinical inclusion guidelines were excluded (Balady et al. 2007, Hevey et al. 2007, Saner & Wood 2009, Piepoli et al. 2010).

The usual standard of care in a CR program included exercise with educational talks on all aspects of CVD. This CR programme comprised of eight consecutive weeks of exercise and education. Each week three exercise with one/two education sessions, were provided by a multidisciplinary team (MDT). In line with current NICE guidelines (2011), this information included BP targets, lifestyle management with dietary advice and medication knowledge, adherence and compliance (<http://www.nice.org.uk/CG127/guidance>). The education was delivered by members of the MDT including dietician, physiotherapist and the nurse.

Study site and population

The study site was a large teaching hospital in Dublin, Ireland. All patients who commenced CR from January 2011-December 2012 were automatically included in the systematic identification and sustained follow-up protocol. As an effectiveness of practice study, the study required and received chairman's approval from the local relevant ethics committee.

Identification and sustained follow-up protocol

The CR nursing staff was responsible for the detection, education and follow up aspects of the BP protocol. In the week prior to the commencement of CR as per usual care each patient had an interview with a CR nurse and individual risk factors for CVD were assessed. BP was measured using validated DINAMAP automated BP monitors that were regularly calibrated (Baseline clinic BP). All nurses had standard training in measuring BP according to guidelines (<http://www.nice.org.uk/CG127/guidance>). If a patient's clinic BP was elevated, they received additional protocol education regarding

normal BP level, lifestyle factors that influence BP and questioned regarding compliance with antihypertensive medication.

In addition to usual care one of the aims of the CR programme highlighted during the introductory talk during week one, was to control BP within target values. As per usual care during the first two weeks of the programme, the CR nurse measured clinic BP pre and post exercise class using the same BP monitors. As per protocol if measurements remained in the hypertensive range, 24 hour ABPM was carried out in week three (Baseline ABPM)

If patients' BP was elevated on the initial ABPM, a one-to-one additional session as per guidelines focusing on lifestyle management for hypertension: salt and alcohol reduction, increased exercise, increased dietary intake of fruit and vegetables, reduction in weight and compliance with medication was conducted by the nurse (<http://www.nice.org.uk/CG127/guidance>). At this time antihypertensive medication was altered if necessary. Clinic BP measurement continued pre and post exercise each week during CR and 24 hour ABPM was repeated during week seven, if target levels were not achieved using clinic BP measurement. If BP remained elevated with repeat ABPM, the patient attended an additional CR clinic for education with the nurse and questioned regarding lifestyle changes and compliance to antihypertensive medication. Further alterations to current medications were made if necessary. This pattern of measuring clinic BP to initially detect hypertension and then to monitor BP response to medication, repeat ABPM and if BP remained uncontrolled, further individual education and drug titration was repeated for up to six cycles of protocol until either: BP was measured within normal range; patients were referred to external cardiology follow-up; or no further intervention was deemed appropriate by the Cardiology Registrar following review of ABPM report.

Criteria and Data collection

In line with current hypertension guidelines thresholds, in this protocol, clinic systolic BP (SBP) of >140mmHg and/or a diastolic BP (DBP) of >90mmHg were defined as hypertension (<http://www.nice.org.uk/CG127/guidance>). High normal was defined as SBP of 130mmHg and DBP as 85mmHg (Perk et al.2012). As per hypertension guidelines ambulatory threshold differ from clinic measured values, a systolic average of >130mmHg and/or a diastolic of >80mmHg were defined as hypertensive (Perk et al.2012).

ABPM was measured using calibrated Spacelabs ABPM monitors and the results were analysed using Spacelabs software and then evaluated by the Cardiology Registrar (O'Brien et al. 2002).

Patients with White Coat Hypertension (WCH) were identified if clinic measurements indicated hypertension but there was no history of hypertension and BP was normal on first ABPM.

All demographic and clinical data was recorded as part of normal cardiac rehabilitation case notes and confidentially extracted for the study 6 months post cardiac rehabilitation.

Analysis

Statistical Package for Social Sciences (SPSS) version 18 was used for analysis. Clinic BP and ABPM were described in the form of mean and standard deviation. Repeated measures ANOVA was used to examine changes in clinic BP over the three time points (baseline BP, end of CR measurement and follow-up clinic appointment

measurement) and paired samples t-tests were used to examine the changes in the ABPM over two time points (baseline ABPM, end of protocol ABPM).

Results:

Sociodemographic characteristics and screening for hypertensive patients

A total of 425 patients attended cardiac rehabilitation (total population), of which 28% had a history of hypertension. Baseline clinic BP measurement revealed that 129 patients had elevated BP ($>140/90\text{mmHg}$) of which 10 patients had high normal BP ($\text{BP}>130/85\text{mmHg}$) (Perk, 2012). Patients with uncontrolled clinic BP ($n=129$) were followed up using protocol (ABPM, education and medication titration) (Figure 1 & 2). The socio-demographic profile of this study population is shown in Table 1.

Baseline ABPM revealed that 62% ($n=80$) of those with uncontrolled clinic BP had ABPM BP within the normal range (Figure 1). These included 15% ($n=19$), who had no previous history of hypertension and were therefore diagnosed as WCH. Of the 38% ($n=49$) with uncontrolled BP, 86% ($n=42$) had a history of hypertension and 14% ($n=7$) were newly diagnosed with hypertension. The uncontrolled hypertensive sample (study population) ($n=49$) were followed up with a maximum of six cycles of protocol until their BP was measured within normal range either by clinic or ABPM or no further intervention was deemed appropriate by the cardiology registrar. Some (7% ($n=9$)), were referred for external cardiology follow-up and 1% ($n=1$) were lost to follow-up (Figure 2, Table 2).

Clinic BP changes

At end of CR only 2 patients in the uncontrolled group was unavailable for Clinic BP, measurements. Both systolic and diastolic, for the uncontrolled hypertensive study

sample (n=47) showed a significant improvement by the end of CR (systolic BP: $F(2, 36) = 33.01$, $p < 0.001$, diastolic BP: $F(2, 36) = 36.00$, $p = 0.001$) (Table 2). By the end of CR there was an average decrease in clinic systolic BP of 18.34mmHg and diastolic BP of 6.49mmHg. By six months post CR, in those available for evaluation (n=29), the overall decrease in clinic systolic and clinic diastolic BP was 17.57mmHg, and 6.45mmHg respectively for but only 31% (9/29) exhibited control (Table 2).

ABPM changes

Baseline systolic and diastolic ABPM BP for the uncontrolled hypertensive study sample (n=49) were 137.89 ± 9.00 mmHg and 76.42 ± 9.87 mmHg respectively (Table 2). At the end of protocol cycles only 35 patients were available for ABPM (10 lost to follow up and four considered not requiring further ABPM from low clinic measurements). Significant improvements were seen in both systolic ($t=3.912$, $p < 0.001$) and diastolic ABPM ($t=2.583$, $p=0.014$). The average systolic and diastolic ABPM decrease was 8.75mmHg and 5.65mmHg respectively (Table 2). A total of 54% (n=19) of the uncontrolled hypertensive study sample exhibiting control using ABPM protocol and 16 remaining uncontrolled, 10 of which had marginal values (systolic ABPM 130-139mmHg). Therefore, despite 10 patients being lost to ABPM follow up, of the original population with elevated clinic BP (n=129), 77% (n=99) patients had their BP under control using protocol.

Changes in drug use

At ABPM baseline, in the uncontrolled hypertensive sample, the average number of hypertensive classes of drugs used was 1.97 ± 0.72 ranging from 0-4 (n=49). Using clinic BP and ABPM respectively, a total of 6% (n=7) and 3% (n=4) patients were defined as having resistant hypertension - prescribed three or more classes of hypertensive drugs but BP still in hypertensive range (Mancia, 2007, Egan 2011). Over the course of the protocols, 69 drug titrations occurred, an average of 1.4 titrations per patient. The average number of hypertensive classes of drugs used in these hypertensive patients at six months was 2.13 ± 0.76 ranging from 1-5. At the end of protocol using ABPM, of those still uncontrolled (SBP>130mmHg) (n=16) only 2 had resistant hypertension.

Discussion

It is evident from previous studies that a multifaceted approach to hypertension control is necessary. Early diagnosis and intervention, education about lifestyle changes, medication titration and compliance, nurse or pharmacist led protocols and in particular sustained monitoring and follow-up are some of the key elements in the effective management of hypertension. This study found that a nurse-led detection and sustained follow-up intervention over six months, embedded within a cardiac rehabilitation programme, utilising additional one to one education sessions, ABPM and drug titration was successful in controlling hypertension.

In this current study using either clinic BP or ABPM measurements 31% and 54% respectively achieved control. This indicates a moderately effective intervention compared to other interventions (32% - 63%) (Uallachain et al. 2006, Welsh et al. 2011)

These improvements in clinic measurements represent a 17.57 mmHg decrease of SBP, a value on the higher side of the range of previous studies (10.2-19.03mmHg) (Uallachain et al. 2006, Chiu& Wong 2010, Pladevall et al. 2010, Magid et al. 2011, Welch et al. 2011). Likewise the decrease in systolic ABPM of 8.75 mmHg was also in line with previous measurements (Fuchs et al. 2012), but as in previous reports, was well below the range seen when using clinic measurements. A similar pattern was observed with regard to diastolic measurements: clinic measurements having a decrease of 6.45mmHg, again within the range of previous studies (5.0 -12.2mmHg) (Uallachain et al. 2006, Pladevall et al. 2010, Chiu & Wong 2010, Magid et al. 2011) and diastolic ABPM values 5.65 mmHg, also in line with previous studies (Fuchs et al. 2012). These significant reductions in BP will be expected to lead to a reduction in the risk of CV events and CVD (Mancia et al. 2007, Mancia et al. 2009, Perk et al.2012, Fuchs et al. 2012), thus increasing cost effectiveness and reducing the health care burden. It has been derived that for each 10mmHg decrease in SBP there is a 30% decrease in CV mortality and a 40% decrease in cerebrovascular disease (Lewington et al. 2002, Lawes et al. 2004). This intervention achieved decreases within this range therefore decreases in mortality and morbidity of this dimension would be expected. Due to the naturalistic design nature of the study we cannot distinguish which element of additional care, education, ABPM or titration of medications were the main factor in achieving these results or how much of the aforementioned changes could be attributed to lifestyle interventions instigated during the CR programme.

Sources of error that occur with clinic BP measurement remain an impediment to accurate diagnosis and treatment of hypertension but maybe reduced by adequate initial training and regular review of performance. The use of ABPM is more reliable

and recommended in the newer prevention guidelines (Perk et al. 2012, <http://www.nice.org.uk/CG127/guidance>). Studies have shown that as many as 25% of people with elevated clinic blood pressure will subsequently have normal ABPM readings (Procter-King 2011). In this study 62% of the patients were no longer diagnosed as uncontrolled hypertensive when ABPM was used. This reinforces the accuracy and necessity for using ABPM and remains one of the main arguments for using ABPM to monitor hypertensive patients.

In this study at baseline 6% of patients exhibited resistant hypertension using clinic measurements. This is below the range of previous studies 7.5% -16% (de las Sierra et al.2012, Daugherty et al.2012). Although there were 69 drug titrations, an average of 1.4 per patient both values were low compared to previously reported interventions (Canzanella et al. 2005). In this study, as in Crowley et al. 2011, there may have been some reluctance of doctors to medicate when BP was only mildly or moderately elevated. Medics were satisfied on occasions if the average ABPM was within high normal range $>130/85$ and $<140/90$ mmHg. There may have been medical reasons for not further titrating drugs i.e. low heart rate and no room to manoeuvre with beta-blockers or patients presenting with side effects from medications. Therefore some of this reluctance may be well founded and represents good clinical judgement, not clinical inertia. This is especially so if clinic measurement of BP is used as the monitoring method, as found in this study when monitored using ABPM, 62% of clinic measured BP turned out to be normal. ABPM can help to assess true hypertension, resistance and clarify if further referral is required once concordance with medications is established.

There may be a need for more specific medication protocols to ensure efficient and more effective drug titration to control hypertension. Specific medication protocols

could be managed if nurse prescribing was available within cardiac rehabilitation programmes. This would make this service cheaper – being nurse led and protocol driven. Cardiac rehabilitation is an ideal cost-effective opportunity to implement a detection, support and sustained follow-up protocol to control patients' BP. Programmes contain appropriate lifestyle education to reduce hypertension and decrease cardiovascular risk through: smoking cessation, weight reduction, alcohol consumption moderation, physical activity, increasing vegetable and fruit intake, decreasing saturated and total fats and reduction in salt intake (Mancia et al. 2007). The multidisciplinary nature of cardiac rehabilitation enables the provision of such education and support in order for patients to understand treatment targets and adjust their lifestyle (Perl et al. 2012).

Conclusion:

The enormity of the challenge of hypertension control demands a coordinated approach. The proportion of patients that achieved BP control compared to other interventions was good. Utilising available resources within cardiac rehabilitation may prove a cost effective method of targeting hypertension, however there was room for further effectiveness through further drug titrations.

Implications for Practice:

- Diagnose hypertension & white coat hypertension with ABPM
- Sustained follow-up protocols are needed to control BP
- Know and utilise guidelines and targets for goal setting
- Holistic approach by a multidisciplinary team is an effective way to educate patients and effect control.

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Table 1: Patients demographics (n=129)

Age		61.87±11.59
Gender (Male)		76.9% (97)
Marital status (married)		92% (115)
BMI		29.97±4.65
Waist Circumference		101.1±11.3
Smoking status	Never	40.5% (51)
	Ex smoker	52.4% (66)
	Current	7.1% (9)
Alcohol (units of alcohol consumed per week)		8.62 ±10.73
Diabetes		15% (19)
Lipid profile	Low density lipoproteins	1.9±0.62
	High density lipoproteins	1.16±0.34
	Total cholesterol	3.71±0.85
	Triglycerides	1.53±1.51
History of hypertension		81.6% (102)
Hypertension medication	Beta blockers	76.9% (97)
	ACE inhibitors	56.3% (71)
	Angiotensin receptor blocker	17.5%(22)
	Calcium channel blockers	19.8% (25)
	Diuretics	3.2%(4)
Treatment	Percutaneous coronary intervention	48.4% (61)
	Coronary artery bypass graft	30.1% (38)
	Medically managed CAD	21.4% (27)
Diagnosis	Coronary artery disease (CAD)	52.8% (66)
	Non ST elevation myocardial infarction	17.6% (21)
	ST elevation myocardial infarction	12.8% (16)
	Angina	6.4% (8)
	Valve Surgery	4.8% (6)
	Other	5.6% (7)
Attendance at CR (% of total course attended)		83.08±13.54

Table 2: Changes in BP over time in the uncontrolled group

	Baseline BP measurement (n=49)	End of CR BP measurement (n=47)	Final BP measurement
ABPM systolic	137.89±9.00		129.14±11.19 (n=29)
ABPM diastolic	76.42±9.87		70.77±10.16 (n=29)
Clinic systolic	162.65±17.06	144.31±14.89	145.08±15.3 (n=35)
Clinic diastolic	84.40 ±11.97	77.91±9.50	77.95±8.94 (n=35)

Figure 1: Flow chart indicating patients BP diagnosis

Figure 2 Follow up of Hypertensive patients using Protocol

*Controlled: indicates patients whose ABPM fell within the target ranges or no further intervention was deemed appropriate by the Cardiology Registrar

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