Ambulatory Monitoring of Blood Pressure

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No Conflicts of Interest
Advantages of Ambulatory Monitoring (ABPM)

- Multiple measurements
- During usual daily activities
- More reproducible than clinic bp
- Evaluate circadian variation in blood pressure
- Assess alerting response (white coat HTN)
- No observer error
- Closer correlation to surrogate hypertensive endpoints
Use in support of,

Not to replace

Office blood pressure monitoring
Devices

- Microphone or oscillometer on blood pressure cuff
- Belt unit with a memory chip
- Desktop interface with the ability to generate a report
- Measures BP q15-20 mins during day
- q20-30 minutes overnight
- Pts keep log: activity, stress, medications
Tolerability

- Recording-related complaints are not rare:
  - Sleep disturbance - any (55%); severe (14%)
  - Pressure on arm, local discomfort
  - Awkwardness
  - Difficulty driving (9%)
  - Noise

- However, 90% of patients would repeat the monitor if needed.

Multicenter, randomized trial in Belgium
419 adults with uncontrolled HTN followed for 6 months
Randomized to management of BP based on ABPM or office blood pressure (OBP)
Antihypertensive treatment was adjusted based on either average daytime ambulatory DBP or average of 3 seated DBP readings by a physician blinded to randomization

Results:
- More ABPM than OBP pts stopped antihypertensives (26 vs 7%)
- Fewer ABPM pts required multidrug therapy (27 vs 42%)
- LV mass, Sokolow-Lyon index, E:A ratio (measures of LVH) similar between groups
- Final mean 24-hour BP in both groups exceeded goals:
  - ABPM: 129/80
  - OBP: 128/79
  - p<0.05 for the differential drop in BP

Conclusions:
- ABPM-based management led to reduced intensity of therapy and similar surrogate outcomes.
- Short duration, use of surrogate outcomes, management based on DBP alone limit this study
Case #1

40 yo overweight WM pediatrician reports for his periodic physical exam. He’s without complaints, but thinks he has pre-hypertension and wonders if it should be treated. Four BP’s from record over the past two years are mostly in 130’s/high 80’s. Highest: 142/90.

VS: 136/88; p70; rr 12. Exam unremarkable. Labwork: Chol: 240; LDL 150; HDL 42; Trigs 220. BUN/Cr 12/1.2.

You order ABPM to evaluate his blood pressure
<table>
<thead>
<tr>
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<th>MIN</th>
<th>MEAN</th>
<th>MAX</th>
<th>STD</th>
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<tbody>
<tr>
<td>Systolic</td>
<td>87 (1-01:04)</td>
<td>133</td>
<td>178 (1-19:04)</td>
<td>22.15 mmHg</td>
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<tr>
<td>Diastolic</td>
<td>48 (1-02:04)</td>
<td>83</td>
<td>119 (1-19:04)</td>
<td>14.50 mmHg</td>
</tr>
<tr>
<td>MAP</td>
<td>61</td>
<td>99</td>
<td>131</td>
<td>16.60 mmHg</td>
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<tr>
<td>Heart Rate</td>
<td>53</td>
<td>71</td>
<td>95</td>
<td>10.67 BPM</td>
</tr>
</tbody>
</table>

Percent of Systolic Readings above period limits: 56.8%
Percent of Diastolic Readings above period limits: 43.2%

Percent of time Systolic was above period limits: 47.6%
Percent of time Diastolic was above period limits: 39.9%

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**SUMMARY PERIOD: 7:00 to 23:00**

<table>
<thead>
<tr>
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<th>MIN</th>
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<tr>
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<td>144</td>
<td>178 (1-19:04)</td>
<td>14.98 mmHg</td>
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<tr>
<td>Diastolic</td>
<td>60 (1-22:34)</td>
<td>90</td>
<td>119 (1-19:04)</td>
<td>10.97 mmHg</td>
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<tr>
<td>MAP</td>
<td>75</td>
<td>106</td>
<td>131</td>
<td>12.76 mmHg</td>
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<tr>
<td>Heart Rate</td>
<td>61</td>
<td>75</td>
<td>95</td>
<td>9.38 BPM</td>
</tr>
</tbody>
</table>

Percent of Systolic Readings > 140 mmHg 67.8%
Percent of Diastolic Readings > 90 mmHg 52.5%

Percent of time Systolic > 140 mmHg 58.4%
Percent of time Diastolic > 90 mmHg 54.1%

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**SUMMARY PERIOD: 23:00 to 7:00**

<table>
<thead>
<tr>
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<th>MEAN</th>
<th>MAX</th>
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</thead>
<tbody>
<tr>
<td>Systolic</td>
<td>87 (1-01:04)</td>
<td>104</td>
<td>131 (1-05:34)</td>
<td>13.85 mmHg</td>
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<tr>
<td>Diastolic</td>
<td>48 (1-02:04)</td>
<td>66</td>
<td>84 (1-05:34)</td>
<td>9.90 mmHg</td>
</tr>
<tr>
<td>MAP</td>
<td>61</td>
<td>80</td>
<td>98</td>
<td>11.12 mmHg</td>
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<tr>
<td>Heart Rate</td>
<td>53</td>
<td>60</td>
<td>63</td>
<td>2.92 BPM</td>
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</table>

Percent of Systolic Readings > 120 mmHg 13.3%
Percent of Diastolic Readings > 80 mmHg 6.7%

Percent of time Systolic > 120 mmHg 14.4%
Percent of time Diastolic > 80 mmHg 7.2%
Evaluation of BP control

- Blood pressure load
  - Refers to proportion of readings above period limits
  - Daytime limits: 140/90 (135/85?)
  - Sleeping limits: 120/80
    - >=40% BP load is considered abnormally high

- This patient’s bp load was high; ABPM adds to the evaluation

- JNC-VII does not recommend use of ABPM for “prehypertension”, but does recommend use for evaluation of control.
Dipper status

- Dipping refers to drop in BP with sleep
  - At least 10% is expected
  - 24.5% dip in mean BP in this example
- “Non-dipper” status is abnormal
  - Blunted decline seen in sleep disordered breathing, autonomic failure, elderly patients
  - Associated with increased prevalence of
    - LVH
    - Albuminuria
    - Peripheral Arterial Disease
    - Cerebral Lacunae
    - Increased Cardiovascular Mortality
“Non-Dipper” Status related to Cardiovascular Mortality

- Cohort study
- 1542 rural Japanese adults; mean age 61
  - 41% on antihypertensive medications
- Baseline ABPM; average 5.1 year f/u
  - Inverted dippers: Increased nocturnal BP
  - Nondippers: 0-10% dip
  - Dippers: 10-20% dip
  - Extreme dippers: >20% dip

Relative Hazard for CV death
- Adjusted for age, sex, smoking, hx cardiovascular disease and antihypertensive med use:
  - Inverted dippers: CV Death RH 3.69 (95% CI: 1.51-09.05)
  - Nondippers: CV Death RH 2.56 (95% CI: 1.16-5.63)
  - Extreme dippers and dippers had similar relative hazard

Conclusions:
- Nondipping status was a risk factor for CV mortality
  - Among treated and untreated patients
  - Nondipping status may be a marker for other CV risk factors
- Extreme dippers did not have elevated risk
  - Other studies have shown elevated stroke risk
- Cohort design limits ability to make conclusions
  - No data about BP control rates among hypertensives
  - No data about comorbid conditions among normotensives
  - Other studies have not found that normotensives with nondipper status have increased CV risk
Obstructive Sleep Apnea Associated with “Non-dipping”

- Obstructive Sleep Apnea (OSA) is associated with sustained HTN in many studies.
- In this Stanford study, 40 US patients with Obstructive Sleep Apnea (OSA); 6 controls without OSA underwent 48 hour ABPM and polysomnogram:
  - 22 (55%) OSA patients were hypertensive
  - 1 non-OSA patient was hypertensive
- Non-dipping defined as >10% drop in ‘average’ night-time bp.

Findings:
- 19/40 OSA patients were systolic non-dippers
- No controls were non-dippers
- OSA patients had higher BP

Conclusions:
- OSA was not only associated with sustained hypertension, but also with non-dipper status

Limitations:
- Small sample size
- Selection bias
Mrs. N is the 60 yo wife of a retired neurologist. She has hypothyroidism, IBS, and HTN and is taking synthroid and HCTZ. She hates for you to take her blood pressure in clinic because “it’s always high when I’m here, but it’s normal at home.”

VS: 148/82; p80; r14. Exam unremarkable; EKG shows NSR without LVH
### SUMMARY

<table>
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<th>MEAN</th>
<th>MAX</th>
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<td>110</td>
<td>138 (1-13:29)</td>
<td>10.82 mmHg</td>
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<tr>
<td>Heart Rate</td>
<td>47</td>
<td>60</td>
<td>75</td>
<td>6.19 BPM</td>
</tr>
</tbody>
</table>

Percent of Systolic Readings above period limits: 2.8 %
Percent of Diastolic Readings above period limits: 1.4 %
Percent of time Systolic was above period limits: 4.2 %
Percent of time Diastolic was above period limits: 0.9 %

### SUMMARY PERIOD: 7:00 to 23:00

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<td>Diastolic</td>
<td>53 (1-17:44)</td>
<td>67</td>
<td>91 (1-13:29)</td>
<td>8.30 mmHg</td>
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<tr>
<td>MAP</td>
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<td>82</td>
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<td>9.66 mmHg</td>
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<td>Heart Rate</td>
<td>52</td>
<td>62</td>
<td>75</td>
<td>5.70 BPM</td>
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Percent of Systolic Readings > 140 mmHg: 0.0 %
Percent of Diastolic Readings > 90 mmHg: 1.8 %
Percent of time Systolic > 140 mmHg: 0.0 %
Percent of time Diastolic > 90 mmHg: 1.3 %

### SUMMARY PERIOD: 23:00 to 7:00

<table>
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<th>MEAN</th>
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<tbody>
<tr>
<td>Systolic</td>
<td>88 (1-23:44)</td>
<td>107</td>
<td>125 (1-03:14)</td>
<td>11.85 mmHg</td>
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<tr>
<td>Diastolic</td>
<td>55 (1-00:14)</td>
<td>68</td>
<td>80 (1-04:44)</td>
<td>9.15 mmHg</td>
</tr>
<tr>
<td>MAP</td>
<td>67</td>
<td>81</td>
<td>92</td>
<td>9.22 mmHg</td>
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<tr>
<td>Heart Rate</td>
<td>47</td>
<td>55</td>
<td>66</td>
<td>4.61 BPM</td>
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</table>

Percent of Systolic Readings > 120 mmHg: 13.3 %
Percent of Diastolic Readings > 80 mmHg: 0.0 %
Percent of time Systolic > 120 mmHg: 14.3 %
Percent of time Diastolic > 80 mmHg: 0.0 %
White Coat Hypertension

- AKA the “alerting” response
- Much skepticism among providers, but may exist in some form in 15-35% of hypertensive patients
- Controversy about treatment
  - Is this prehypertension?
- ABPM can be used periodically to evaluate White Coat HTN and guide treatment
White Coat Hypertension

- Virtually every study of ABPM and white coat HTN defines “normal” ABPM differently.
  - Systolic and diastolic
  - Diastolic alone
  - Average daytime bp
  - Average 24-hour bp
  - Difference between office and ABPM

- Difficult to compare studies
PIUMA study

- Patients: 1187 Italian adults with essential HTN; 205 healthy normotensives
- Intervention: ABPM off therapy at baseline; followed for 7.5 years
  - 19.2% of hypertensives had White Coat HTN
    - Defined as average daytime ABPM <131/86 in women; <136/86 in men
  - Compared normotensive group to white coat hypertensives, dippers, and non-dippers
- Virtually no LV hypertrophy on echo below ABPM systolic of 120 mm Hg

Figure 1. Association between average daytime ABP and LV mass at echocardiography in 2046 untreated subjects with essential hypertension. BSA indicates body surface area. (From Verdecchia et al[49] with permission.)
Combined fatal and nonfatal CV events
- Normotensive: 0.47/100 patient-years
- WCH: 0.49/100 pt-yrs
- Dippers: 1.79/100 pt-yrs
- Non-dippers: 4.99/100 pt-yrs

CV event rate increased markedly when moving from more restrictive to more liberal definitions of ABPM normalcy over a relatively narrow range

Conclusion: CV event rate in white coat hypertension is similar to normotensive event rate

Limitations:
- Unclear degree of blood pressure control between the groups during follow-up
- No adjustment for other comorbidities
Figure 2. Rate of major CV morbid events in a normotensive group (A), 2 groups with WCH defined with a restrictive (B) or liberal (C) criterion, and a group with ambulatory hypertension (D). (From Verdecchia et al. with permission.)
What to do with white coat hypertension?

- Antihypertensive treatment may be unnecessary in some of these patients
- However, concomitant risk factors
  - Diabetes, smoking, elevated lipids, for example
- may signify the need to treat these patients for hypertension
- Withhold treatment in WCH if
  - Average daytime ABP<130/<80
  - No comorbid cardiovascular risk factors
  - Adequate follow-up

Case #3

77 yo obese man referred to you because of uncontrolled HTN. He has had a CABG, and has CRI (cr 1.8); GERD; BPH; and hyperlipidemia. He is taking metoprolol 50 bid, ramipril 10 mg bid, amlodipine 10 mg qd, chlorthalidone 12.5 qd, atorvastatin 40 qd, omeprazole 20 qhs, metamucil, asa 325 qd, and celecoxib. He doesn’t take alternative medications. He has no complaints, but asks “Is Cialis right for me?”

BP 180/70. Lungs clear; CV rrr without mur; no abd bruits, masses; extremities with good pulses and no edema.

What is the role of ambulatory monitoring?
Resistant Hypertension

- Many considerations here beyond ABPM
  - Adequacy of diuretic regimen
  - Avoiding NSAIDs
  - Pseudohypertension, secondary causes
- Consider referral to HTN specialist
- ABPM may be helpful
  - Obtain a general idea of the degree of control
  - May uncover a component of white coat HTN
  - In one study, 28% percent of resistant HTN pts had normal daytime ABPM*

Ambulatory BP and CV events in resistant HTN

- Multicenter cohort study
- 86 caucasian pts in Spain with resistant HTN (diastolic>100 despite 3 drugs including diuretic)
- Intervention: baseline ABPM, blood pressure management based on office blood pressure, f/u 4 years
- Divided into three groups based on ABPM:
  - Highest tertile (n=29): mean diastolic ABPM>97 mm Hg
  - Middle (n=29): mean diastolic ABPM 88-97 mm Hg
  - Lowest (n=28): Mean diastolic ABPM <88 mm Hg
- Office BP was higher than daytime ABPM in 92% (80 of 86 patients)

Blood pressure reduction was similar in all three groups by the last clinic visit.

After controlling for age, gender, smoking, LVH, office BP (p<0.02 for comparison):
- CV Event rate in upper tertile of BP load: 13.6/100 pt-yrs
- Middle tertile: 9.5/100 pt-yrs
- Lowest tertile: 2.2/100 pt-yrs
- p<0.05

Neither office systolic nor office diastolic blood pressure at baseline or final visit were associated with CV event rate (Cox model).

Conclusion: ABPM has prognostic value in resistant HTN.

Limitations: Small sample size, no adjustment for lipid levels, only did baseline ABPM (vs regular ABPM during f/u).
Case #4

Mr. K comes in for his annual visit. He is 75, and doesn’t trust “those quacks” in his rural community. He’s on simvastatin for hyperlipidemia, HCTZ and ramipril for HTN, and a daily baby aspirin. He has no complaints.

VS: 146/88; p70; r12. His lipid panel is at goal. You don’t have enough BP measures to make a good decision.

ABPM: 90% load; 5% dip
Assessing Adequacy of Control

- His BP is poorly controlled, despite the near normal clinic BP
- Disparate readings during infrequent clinic visits, and
- Borderline control during clinic visits
  - Raise the question of whether to treat
  - ABPM can be used to risk stratify
ABPM higher than office BP associated with higher CV risk

- Patients: Cohort study of 1076 US adults at UCSF (mean age 44.5) with HTN followed for 5 years
- Intervention: Baseline office (OBP) and ambulatory blood pressure (ABP). Results:
  - High group: ABP-OBP >=10/6 mm Hg
  - Low group: ABP-OBP <= (-)10/(-)6 mm Hg
  - High group had statistically significantly more clinical cardiovascular events and cardiovascular morbidity
- Conclusion: ABP discriminated cardiovascular risk between hypertensive patients with similar office blood pressures.

BP variability does not correlate with CV risk

- PIUMA study: High or low BP variability defined as standard deviation of daytime and nighttime systolic BP above or below mean SD
  - LV mass did not differ among groups
  - After adjustment for prior CV events, age, BP control and DM:
    - no difference in new CV event rate was seen

- Age, DM, previous CV events are potential markers of vascular damage and reduced baroceptor sensitivity and may lead to high BP variability
Case #5

86 yo WM reports for routine office visit complaining of dizziness. He describes occasional near-syncope when rising from a sitting position. No vertigo; no unsteadiness. He has not fallen. Meds: atenolol 50; hctz 25; ASA 325; mvi

BP 110/52; p56. Orthostatics negative. Thin, elderly man in NAD; otherwise exam is unremarkable. BMP is unchanged.

ABPM reveals load of 5% with normal nocturnal dip. Systolic blood pressure nadir of 80 twice during the study.
Treatment-related Hypotension

- Regularly suspected historically, especially in the extreme elderly
- Consider reduction of dosing of antihypertensive medications in the elderly
  - Even without documented drop, with his symptoms and low bp load – reasonable to reduce dosing

- ABPM not essential for diagnosis
  - Trial of reduced dose antihypertensives is ok
- But ABPM can confirm the diagnosis.
Summary

- Principal Indications for ABPM
  - Evaluate White Coat Hypertension
  - Adjunctive management of resistant hypertension
  - Assess adequacy of control
    - Pre-hypertensives
    - Patients with infrequent followup
  - Post-prandial or treatment-related hypotension
Getting Started with Ambulatory Monitors

David Brett-Major, MD
G Dodd Denton, MD MPH FACP
Hypertension Clinic Director
National Naval Medical Center, Bethesda
So, you want to conduct ABPM…

1. Identify the need.
2. Survey your own resources.
3. Select an ambulatory blood pressure monitor.
4. Develop an office testing protocol.
5. Train the relevant staff.
6. Include the monitors in your biomedical equipment recertification cycle.
**Cost**

- Ranges from $1500 to 5000 with varying component and service packages.

- Table to Right from a market analysis by TIBA.

- Medicare reimbursement is based upon evaluation for White Coat Hypertension.

- Some companies also have lease options.

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**Reimbursement Guidelines**

**Market Studies of Example Reimbursements Rates**

**CPT Code: 93784 - 24 hour Ambulatory Blood Pressure Monitoring**

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<tr>
<th>Insurance Company</th>
<th>Reimbursement Ranges</th>
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<td>Aetna HMO</td>
<td>$170-$200</td>
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<tr>
<td>Cigna HMO</td>
<td>$160-$260</td>
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<tr>
<td>Cigna PPO</td>
<td>$170-$300</td>
</tr>
<tr>
<td>Blue Cross/Blue Shield</td>
<td>$60-$70</td>
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<td>Federal Reserve Bank</td>
<td>$325-445</td>
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<td>First Health</td>
<td>$170-$190</td>
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<td>Medicare</td>
<td>$62-$100</td>
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<td>Pacificare HMO</td>
<td>$180-$210</td>
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<td>PHCS PPO</td>
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<td>Randalls</td>
<td>$360-$500</td>
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<tr>
<td>Unicare Performance PPO</td>
<td>$310-$330</td>
</tr>
<tr>
<td>United HMO and PPO</td>
<td>$55-$60</td>
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*Please contact your IPA or your provider representative for your contracted rates*
Cost Effectiveness

- Charge ranges from $100-350 in the US
- Until recently, many 3rd party payers would not pay for test
  - Labeled “investigative”
- Medicare now reimburses for ABPM in patients with suspected white-coat HTN
- Overall costs are equivalent
  - Management using ABPM usually results in less medication use
  - Fee for ABPM is less than savings from medication avoidance
### Essential messages
- Consider carefully which monitor to buy
- Consider which type of service is best suited to your needs
- Consider analysis and presentation of data
- Exclusion of white coat hypertension is a major indication
- The technique is valuable in the elderly
- The technique is being increasingly used in pregnancy

### Which monitor to choose
- Check for independent validation by BHS/AAMI protocols
- How much will it cost?
- How expensive is the software?
- Is the software what you need?
- Are the instructions adequate?
- How much will maintenance cost?
- How expensive are consumables—batteries, etc?
- Have you adequate computer facilities?
- Is the technical/nursing back up available?
- Are training facilities available?
- Is the warranty adequate?
- Is there an adequate servicing facility?
Working Group on Blood Pressure Monitoring of the European Society of Hypertension International Protocol for validation of blood pressure measuring devices in adults

Blood Pressure Monitoring 2002, 7:3–17

<table>
<thead>
<tr>
<th>Number</th>
<th>Phase 1 Fifteen subjects</th>
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<tr>
<td></td>
<td>Phase 2 Thirty-three subjects</td>
</tr>
<tr>
<td>Sex</td>
<td>Phase 1 At least five male and five female</td>
</tr>
<tr>
<td></td>
<td>Phase 2 At least 10 male and 10 female</td>
</tr>
<tr>
<td>Age range</td>
<td>All subjects should be at least 30 years of age</td>
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<tr>
<td>Arm circumference</td>
<td>Distribution by chance</td>
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<tr>
<td>Blood pressure range</td>
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<table>
<thead>
<tr>
<th>Table 1 Blood pressure ranges for entry blood pressure (BPA)</th>
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<tr>
<td>SBP</td>
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<tr>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Low</td>
</tr>
<tr>
<td>Medium</td>
</tr>
<tr>
<td>High</td>
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For the primary phase, five of the 15 subjects should have a systolic blood pressure (SBP) in each of the ranges. Similarly, five of the 15 subjects should have a diastolic blood pressure (DBP) in each of the ranges. For the secondary phase, 11 of the 33 subjects (including the first 15 subjects) should have SBP and DBP in each of the ranges. It is recommended that recruitment should commence by targeting subjects likely to have pressures in the low-systolic and high-diastolic ranges, then progressing to complete the high-systolic and low-diastolic ranges so that it will be easy to complete the recruitment with the remaining medium ranges.
Peer-Reviewed, Validated Auscultatory or Oscillatory Monitors

- DIASYS Integra ES-H531
- Kontron AM-5600
  - c EKG, compared to intra-arterial monitoring
- LifeSource TM 2430
- Schiller BR 102
- SpaceLabs 90207
  - x elderly high SBP and adolescent DBP
- SpaceLabs 90217
- SunTech Accutracker II
- SunTech Oscar2
Additional Monitors
Advertised in U.S. include...

- CardioLabs/ TIBA
- Welch Allyn 6100-200
- ... and a variety advertised on the European market working for share here.
European Society of Hypertension recommendations for conventional, ambulatory and home blood pressure measurement


Table 5  Using an ambulatory blood pressure monitor

- 15–30 min needed
- Relax patient in a quiet room
- Enter patient's details into monitor
- Measure BP in both arms
  - If SBP difference <10 mmHg, use non-dominant arm
  - If SBP difference ≥10 mmHg, use arm with greater pressure
- Select appropriate cuff
- Select frequency of measurement – usually every 30 min day and night
- Inactivate LCD display
- Give patient written instructions and a diary card
- Instruct patient how to remove and inactivate monitor after 24 h

BP, blood pressure; SBP, systolic blood pressure.
Instructions for patients
(To be explained to patient and reinforced on instruction/diary card)

- Explain procedure
- Explain frequency of inflation and deflation
- Explain how to deflate manually
- Explain about failed measurements and what the monitor will do
- Instruct to keep arm steady during measurement
- Instruct to keep arm at heart level during measurement
- Instruct to engage in normal activities between measurements
- Instruct to keep monitor attached at night
- Instruct to place monitor under pillow or on bed at night
- Provide a help line number for problems or anxiety
- Provide diary card for the following:
  level of activity at time of blood pressure measurement
  time of going to bed
  time of rising
  time of taking medication
  record any symptoms
Presenting the data

- Number of measurements
  - Day > 14 SBP and DBP measurements
  - Night > 7 SBP and DBP measurements
- Causes of poor ABPM
  - Poor technique
  - Arrhythmias
  - Small pulse volume
  - Inability of automated devices to measure blood pressure
- Editing data
  - Restrict editing to physiologically impossible pressures, e.g. DBP = SBP
- Displaying data
  - Plot data (see figure)
  - Statistics to include:
    - Mean daytime SBP and DBP and heart rate
    - Mean nighttime SBP and DBP and heart rate
    - Mean 24-hour SBP and DBP and heart rate
Questions?


Can non-dipper status be purposefully changed?

A NNMC Human Research Protection and Resources Division approved project.
Review: Dipper Status

- Normal nocturnal BP dip 10-20%
- Non-dippers have increased rate of CV events
- An association with secondary HTN is suspected
TREND: And, hypothesis testing...

- In our population, what is the rate of undiagnosed OSA in such patients?
- Is there an association with smoking?
- Does changing dipper status impact quality of life or cardiovascular risk?
An IRB approved, prospective, randomized controlled trial

Initial planned enrollment
- 60 Non-Dipper HTN >40yo
- Captured from ABPM Clinic and general solicitation

Serial ABPM at 0, 1, 3, and 6 months

Usual care and intervention arms
- Data shared with primary physician
- Adjustment of BP medications in order to create a nocturnal dip
TREND: Lessons Learned

- Individual patient dipper status variability
  - Stable BP load and mean daytime BP
  - 60% of patients varied in dipper status on serial measurements

- Patient discomfort during monitoring
  - Only 10% of known non-dippers were willing to undergo serial ABPM
TREND: the setting

- Internal Medicine, NNMC
- ABPM Clinic (referral) and Refractory Hypertension Clinic
- 1 clinic nurse (trained on the software)
- 1 pentium Windows-based computer
- 4 monitors