Blood Pressure

Blood Pressure (mm Hg) – pressure exerted by blood against arterial walls
- Systolic – pressure exerted on arteries during systole
- Diastolic – pressure in arteries during diastole
  - 120/80
  - Borderline >140/90
  - Hypertension > 160/100
- AHA Classification System p 33 Guidelines

Blood Pressure
- Pulse pressure – pressure felt when artery is palpated
  - SBP – DBP
  - 120-80 = 40 mm Hg
- MAP – average pressure in the arteries
  - (DBP + 1/3 PP) Rest = 93 mm Hg
  - (DBP + ½ PP) Exercise
  - MAP = Q X TPR

Blood Pressure
- Total Peripheral Resistance – sum of all forces which oppose flow
  - SBP – indicative of SV
  - DBP – indicative of TPR
Normal Resting BP

- Resting BP – 120/80
- Resting PP – 40 mm Hg
- Resting MAP – 90-100 mm Hg
- Pulse Pressure – 40 mm Hg
- RPP (Rate Pressure Product)
  - HR X SBP/100
  - Indicative of myocardial oxygen consumption

BP Response to Exercise

- Systolic Pressure – increase
  - ≤ 200 mm Hg
- Diastolic Pressure – stay same or decrease
- Pulse Pressure – increase
  - 40-100 mm Hg
- MAP – increase slightly
  - 90-130 mm Hg
- Total Peripheral Resistance - decreases

BP Response to Exercise

Systolic Pressure – increase
- ≤ 200 mm Hg
Diastolic Pressure – stay same or decrease
Pulse Pressure – increase
- 40-100 mm Hg
MAP – increase slightly
- 90-130 mm Hg
Total Peripheral Resistance - decreases

During Exercise

WHY ???????

- SBP increase
  - Sympathetic NS dominant
  - Increase in SV and contractility
- DBP stay same or decrease (may fall to near zero) – 4th sound better depiction – record both if possible
  - Sympathetic NS dominant (vasoconstriction in nonworking musculature)
    - Shunt blood to working muscle
  - Local metabolic control (vasodilation in working muscles due to metabolites)
    - Vasodilation in working muscle only

Exercise vs Stress

- What is the difference?
  - SBP – increase both
  - DBP – increase stress
    - Due to vasoconstriction with no vasodilation (no working muscle)

Post Exercise BP

- Decrease in SBP to resting values
- DBP may drop below pretest values for several hours post X
Supine Exercise

- Lower SBP
  - Heart does not work as hard to pump blood to body

Dynamic Arm vs Leg Work
Given % VO2max

- SBP and DBP higher
- Vasoconstriction in large inactive musculature of legs
- Vasodilation in small muscle groups
- Smaller muscle mass in arms requires a greater % of available mass to perform the work

Resistance Training

- Isometric
- WHYYYY??
- MAP - increase
- HR - increase
- SV – NC
- TPR – increase
  - partial or full occlusion of vessels in working muscle
  - vasoconstriction of vessels in nonworking muscle

** Can get total occlusion of arterial flow at >15% of MVC in certain muscle groups

TABLE 15.3. Comparison of systolic and diastolic blood pressure during arm and leg exercise at similar percentages of the maximal oxygen intake

<table>
<thead>
<tr>
<th>PERCENT OF MAX VO2</th>
<th>SYSTOLIC PRESSURE (mm Hg)</th>
<th>DIASTOLIC PRESSURE (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ARMS</td>
<td>LEGS</td>
</tr>
<tr>
<td>25</td>
<td>150</td>
<td>132</td>
</tr>
<tr>
<td>40</td>
<td>165</td>
<td>138</td>
</tr>
<tr>
<td>50</td>
<td>175</td>
<td>144</td>
</tr>
<tr>
<td>75</td>
<td>205</td>
<td>160</td>
</tr>
</tbody>
</table>


Resistance Training

- SBP and DBP increase
- Isotonic
- WHYYYY??
- MAP - increase
  - Increase - HR
  - NC - SV
  - TPR – increase
  - Constriction of vessels in nonworking muscle
  - Compression of vessels in working muscle

TABLE 15.2. Comparison of peak systolic and diastolic blood pressure during isometric and standing free weight and resistive resistive exercises

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>Systolic (%)</th>
<th>Free weight, peak systolic (mm Hg)</th>
<th>Standing, peak systolic (mm Hg)</th>
<th>Standing, peak diastolic (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak static</td>
<td>170</td>
<td>280</td>
<td>225</td>
<td>106</td>
</tr>
<tr>
<td>Peak dynamic</td>
<td>180</td>
<td>195</td>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>

Values are means for 3 subjects. Data from references 6 and 8.

*Open gluteus maximus exercises, change of 3ometric, same position as that of neck press exercise with hands at hips in the first session.
*The weight lifted was either 25 or 32%, at previously determined isometric MVC.
**Reps done on a 3ometric, data taken at right after 20sec. and 30sec. for 30 seconds of repeated maximal contractions.
Static Contractions

Increase BP
- Stabilize torso
- Cycling
- Free weight resistance training
- Minimize if hypertensive

Minimize BP Response to Resistance Training
- Decrease resistance
- Decrease size of muscle mass utilized
- Select exercises that require minimal stabilization
- Breathing
- Do not perform sets to fatigue

Static Exercise Modifies Response to Dynamic Exercise (Lind et al.)
- Walked 3 mph, 22% grade
  - No hand grip
  - With isometric hand grip of 50% MVC
- During gripping
  - SBP increased 45 mm Hg
  - DBP increased 40 mm Hg

Effect of Fitness Level on BP
- Normotensives – no change or a slight decrease
- Borderline Hypertensives
  - SBP decrease 8-10 mm Hg
  - DBP decrease by 5-8 mm Hg

Orthostatic Hypotension
- Inability to maintain BP with a change in posture

Baroreceptors
- Baroreceptors
  - Regulate blood pressure
  - Carotid sinus and aortic arch
  - Nerve endings
  - Send impulses to medulla
  - Decrease pressure – vasoconstriction and increase in HR
  - Increase pressure – vasodilation and decrease in HR
- Not control hypertension long term, reset in several days
Supine to Standing

- Immediate – drop in SBP and DBP
- Blood pools in legs
- After baroreceptors sense drop in pressure
- Vasoconstriction and increase in HR
- Increase in SBP and slight increase in DBP

Supine to Seated

- No practical difference
- BP tends to be about 6-7 mm Hg SBP and 1 mm Hg DBP higher in supine position

Important Points

- All persons 30 years and older should have their BP checked annually
- Round up to nearest even number
- Go 10 mm Hg past the last sound to be sure you have true DBP
- Abnormally high SBP response to exercise – more likely to develop future resting hypertension

Valsalva Maneuver

- Expiratory effort with glottis closed
- Not breath-holding alone
- Intrathoracic pressure increases
- Causes collapse of veins in chest cavity
- Blood pressure increases
- If held, blood pressures drops due to decrease in venous return

Sources of Error

- Erroneously low
  - Cuff too large
  - Deflate cuff too quickly
  - Arm above heart
- Erroneously high
  - Cuff too small
  - Arm unsupported
  - Insufficient rest
  - Cuff too loose
  - Deflate cuff too slowly
Measuring BP
- Legs not crossed
- First time – measure both arms
- Then use arm with highest BP
- Should be \( \leq 10 \) mm Hg difference
- Some normal variants
- Should refer

Hypertension
- 40 million Americans
- 2 types
  - Primary or essential
    - Unknown cause – 95%
    - Reason treat with multifaceted approach
  - Secondary – caused by a specific endocrine or renal abnormality
    - Often treatable or manageable
    - Associated with high alcohol intake

Why is hypertension bad?
- Damages vessel linings
- LVH (left ventricular hypertrophy)
- Increase incidence of stroke
- Overloads organs