Post Transplant Hypertension:
Why does this transplanted child have a BP of a 60 year old?

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Nothing to disclose

Hypertension in Pediatric Solid Organ Transplants

- Hypertension most common modifiable CV risk factor in children post Renal Tx
- NAPRTCS registry indicates that immediately post-transplant >80% of children require antihypertensive medications
- 70% of DDRT and 60% of LRRT require antihypertensive medications 5 yrs after transplantation
- One study found for each 10% increase in SBP at 1 yr post-transplant there was a two-fold risk for subsequent graft failure

Weir, et al, JASN 2015
Hypertension in Liver Tx

- ~40% of pediatric liver transplant recipients develop CKD post-transplant
- ~25% are left with clinical hypertension
- ABPM studies echo this at a 30% prevalence of masked hypertension

McLin et al., AJT, 2012  
Matloff, CGR, 2015

Hypertension in Heart Tx

- Common, severe and occurs frequently at night
- Associated with the number and type of immunosuppressive agents used, specifically with the combo of Sirolimus and Prednisone
- Difficult to control, therefore advocating for alternative interventions like decreased sodium intake

Filler, PT, 2016  
Roche, JHLT, 2008

Hypertension in Lung Tx

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Within 1 Year</th>
<th>Total N with known response</th>
<th>Within 5 Years</th>
<th>Total N with known response</th>
<th>Within 7 Years</th>
<th>Total N with known response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>41.4%</td>
<td>(N = 765)</td>
<td>67.7%</td>
<td>(N = 229)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renal Dysfunction</td>
<td>9.4%</td>
<td>(N = 79)</td>
<td>29.6%</td>
<td>(N = 247)</td>
<td>42.8%</td>
<td>(N = 118)</td>
</tr>
<tr>
<td>Abnormal Creatinine &lt; 2.5 mg/dl</td>
<td>6.5%</td>
<td></td>
<td>24.1%</td>
<td></td>
<td>32.6%</td>
<td></td>
</tr>
<tr>
<td>Creatinine &gt; 2.5 mg/dl</td>
<td>1.3%</td>
<td></td>
<td>4.0%</td>
<td></td>
<td>6.1%</td>
<td></td>
</tr>
<tr>
<td>Chronic Dialysis</td>
<td>0.5%</td>
<td></td>
<td>1.0%</td>
<td></td>
<td>0.7%</td>
<td></td>
</tr>
<tr>
<td>Renal Transplant</td>
<td>0.3%</td>
<td></td>
<td>0.8%</td>
<td></td>
<td>2.9%</td>
<td></td>
</tr>
</tbody>
</table>

Fifth Task Force Data, Pediatrics, 2004

Pediatric Hypertension Definitions

BP Classification

- Normal BP: <90th percentile
- Pre-Hypertension: 90th percentile to <95th percentile; adolescents BP >120/80 up to <95th percentile
- Stage 1 hypertension: 95th percentile up to the 99th percentile plus 5 mm Hg
- Stage 2 hypertension: >5 mm Hg above 99th percentile

4th Task Force Data, Pediatrics, 2004
BP measurement standards

- Measure BP in all children ≥3 years old or <3 years old with chronic illness
- Auscultation is preferred method
- Use appropriate BP cuff size
  - length should cover 80%-100% of the upper arm circumference
  - bladder width ≥ 40% of arm circumference
- High BP must be confirmed on repeated measurement
- BP >90th percentile obtained by oscillometric device should be repeated by auscultation

Ambulatory Blood Pressure Monitoring

- Oscillometric measurement of BP over a 24 hour period
  - Daytime: every 20-30 min
  - Nighttime: every 30-60 min
- Standards are established for normals based on European pediatric patients ages 6-17
- Results are expressed as Systolic and Diastolic Load

Ambulatory Blood Pressure Monitoring

<table>
<thead>
<tr>
<th>Classification</th>
<th>Clinic BP*</th>
<th>Mean Ambulatory (SBP)</th>
<th>SGF Load, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal BP</td>
<td>&lt;95th percentile</td>
<td>&lt;95th percentile</td>
<td>&lt;25</td>
</tr>
<tr>
<td>White coat hypertension</td>
<td>&gt;95th percentile</td>
<td>&gt;95th percentile</td>
<td>&gt;25</td>
</tr>
<tr>
<td>Masked hypertension</td>
<td>&lt;95th percentile</td>
<td>&gt;95th percentile</td>
<td>&gt;25</td>
</tr>
<tr>
<td>Prehypertension</td>
<td>&gt;95th percentile</td>
<td>&gt;95th percentile</td>
<td>25-50</td>
</tr>
<tr>
<td>Ambulatory hypertension</td>
<td>&gt;95th percentile</td>
<td>&gt;95th percentile</td>
<td>25-50</td>
</tr>
<tr>
<td>Severe ambulatory hypertension (at risk for end-organ damage)</td>
<td>&gt;95th percentile</td>
<td>&gt;95th percentile</td>
<td>&gt;50</td>
</tr>
</tbody>
</table>
Masked Hypertension
- BP <95% in office setting but >95% by ABPM
- Prevalence ~8% in unselected pediatric population
- Prevalence in pediatric solid organ tx patients is ~26-46%
- Associated with higher LV mass in children
- Risk of LVH as high as in those with ambulatory HTN

Hypertension in pediatric solid organ transplants

<table>
<thead>
<tr>
<th>Classification, %</th>
<th>Renal Tx (n=111)</th>
<th>Heart Tx (n=20)</th>
<th>Liver Tx (n=13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal BP</td>
<td>13 (14)</td>
<td>21 (6)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>White-coat hypertension</td>
<td>2 (2)</td>
<td>3 (1)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Prehypertension</td>
<td>5 (5)</td>
<td>3 (1)</td>
<td>8 (1)</td>
</tr>
<tr>
<td>Masked hypertension</td>
<td>26 (29)</td>
<td>45 (13)</td>
<td>46 (13)</td>
</tr>
<tr>
<td>Ambulatory hypertension</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Severe ambulatory hypertension</td>
<td>38 (42)</td>
<td>26 (8)</td>
<td>23 (3)</td>
</tr>
<tr>
<td>Unclassified ambulatory BP monitoring</td>
<td>15 (17)</td>
<td>0 (0)</td>
<td>23 (3)</td>
</tr>
</tbody>
</table>

Tainio, JCH, 2015

Nocturnal Hypertension
- BP should decrease 10-20% at night
- BP which does not decrease at night is considered non-dipping with diagnosis of nocturnal hypertension
- Risk of LVH is equal to those with ambulatory HTN
- Hypertensive BP values can occur at night even in patients taking anti-hypertensive medications

Hypertension across all transplants
- Multifactorial:
  - Impaired renal function
  - Medication induced hypertension (Calcimurin-inhibition and corticosteroids)
  - Fluid overload
  - Obesity
Impaired Renal Function

- Renal perfusion compromised by hemodynamic instability, hypotension and prolonged cross-clamp time can lead to ischemia and AKI
- Repeated episodes of AKI, regardless of interim return to baseline function, are associated with impaired renal function and progression to CKD
- Hypertension is a hallmark of CKD and is independently associated with CKD progression
- Strict BP control can substantially slow CKD progression

Medication-induced hypertension

- Calcineurin inhibitors cause vasoconstriction of the afferent and efferent glomerular arterioles, reduction in renal blood flow and thereby decreased GFR
- Impairment of endothelial cell function leads to reduced production of vasodilators and enhanced release of vasoconstrictors
- Sodium retention and sensitivity is related to afferent glomerular arteriole vasoconstriction and activation of sodium chloride co-transporter

Classes of Antihypertensive Drugs

- Diuretics
- Direct acting vasodilators
  - Hydralazine, minoxidil, nitroprusside
- Sympathetic blockers
  - Central: clonidine
  - β receptor: propranolol, metoprolol
  - α and β receptor: labetalol
- Angiotensin blockade
  - ACE I: enalapril, benazepril
  - ARB: candesartan
- Calcium channel blockers
  - Nifedipine, amlodipine, nicardipine

Choice of Antihypertensive Drug Based on Likely Etiology

- Fluid overload, steroid therapy  Diuretics
- Renal injury/scarring  ACE I, ARB
- Renal artery stenosis  ACE I, ARB
- CSA, Prograf  Calcium channel blockers
- CNS disease  Clonidine
- Adolescents  Once daily therapy
So why does your patient have a BP of a 60 yr old?

- Look at the prevalence of the specific solid organ transplant
- Multifactorial but could be due to medication, decreased renal function, fluid overload or obesity
- You diagnosed with a 24 hr ABPM
- You can treat based on the underlying pathology
- Monitor with yearly with ABPM and ECHO

Resources


Resources Continued

Resources Continued


