The nursing role in prevention of organ stunning

Jessica Geer, MSN, C-PNP, CNN-NP
Objectives

• Understand the problem of cardiovascular morbidity and mortality in our dialysis patients

• Discuss research regarding organ stunning

• Identify possible interventions for prevention of organ stunning in dialysis patients
Causes of hospitalizations for children with CKD

Cardiovascular disease in CKD

• Cardiovascular disease is a leading cause of death in children with CKD
  - Arrhythmias
  - Valvular heart disease
  - Cardiomyopathy
  - Sudden cardiac death
Traditional risk factors

• Traditional risk factors (hypertension, hyperlipidemia) can be present
  - Generally don’t see atherosclerosis of the vessels

• Left-ventricular hypertrophy
  - CKiD study- only half of the patients had controlled BPs by 24 hour ambulatory monitoring
Cardiovascular Risk in ESRD

• Children receiving dialysis have cardiovascular mortality rates almost 1000-fold higher than age-matched healthy peers (Mitsnefes, 2012).

• Life expectancy of child on dialysis compared to general population is much lower.
Myocardial stunning

• Definition -

*Myocardium that suffers transient reversible myocardial contractile dysfunction induced by acute ischemia*

• Repeated stunning leads to myocardial hibernation

□ congestive heart failure
Cardiovascular risk in ESRD

Pediatric Myocardial Stunning Underscores the Cardiac Toxicity of Conventional Hemodialysis Treatments

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Cardiovascular risk in ESRD

• Single-center HD patients

• N = 12 (2-17 years of age)

• Obtained serial echocardiograms (before HD, during HD and 15 min after HD)

• Significant stunning = 20% reduction in regional wall motion in 2 or more segments and hyperkinesis
Results

• 11 out of 12 patients developed myocardial stunning

• Strong correlation between intradialytic systolic BP change and mean segmental shortening fraction

Cardiovascular Risk in ESRD

Faster rate of blood volume change in pediatric hemodialysis patients impairs cardiac index

Ultrasound Cardiac Output Monitor

- Measures blood flow across the heart valves using continuous wave Doppler ultrasound.
- A non-invasive system of hemodynamic measurement.
- Beat-to-beat cardiac output and stroke volume
Inclusion & Exclusion Criteria

• Inclusion
  - ESRD patients on hemodialysis for > 3 months
  - Patients > 5 years old

• Exclusion
  - Underlying congenital heart disease or cardiomyopathy from etiology other than CKD
Methods

- Hemodialysis (HD) was performed using linear fluid removal over 4 hours.

- Continuous wave Doppler ultrasound was used to measure hemodynamic parameters pre HD, 120 minutes into HD, and post HD during a single, mid-week treatment.

- Non-invasive hematocrit monitoring was utilized during dialysis treatments.
Results

• 12/22 (54%) pts had significant decline in cardiac index

<table>
<thead>
<tr>
<th></th>
<th>Cardiac Index (L/min/m²)</th>
<th>Stroke Volume (cm³)</th>
<th>Systemic Vascular Resistance Index (dynes-sec/cm–5/m²)</th>
<th>Heart Rate (beat/min)</th>
<th>Pulse Wave Velocity (m/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>3.38 (2.9, 4.58)*</td>
<td>69.6 (58.04, 83.52)*</td>
<td>1973 (1750, 2640)</td>
<td>81(76,93)*</td>
<td>6.55 (5.8, 8.3)</td>
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<tr>
<td>Intra (120 min)</td>
<td>3.24 (2.5, 3.82)*</td>
<td>52.23 (43, 63)*</td>
<td>2100 (1768, 2357)</td>
<td>91(84,102)*</td>
<td>7.1 (6.7, 8)</td>
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<tr>
<td>Post</td>
<td>3.33 (2.9, 3.74)</td>
<td>55.87 (48.13, 62.31)</td>
<td>1940 (1649, 2373)</td>
<td>91(80,97)</td>
<td>6.6 (5.6, 7.5)</td>
</tr>
</tbody>
</table>

Values expressed median (IQR); *= p-value < 0.005
## Results

<table>
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<tr>
<th></th>
<th>UF (ml)</th>
<th>Wt (kg)</th>
<th>Age (yrs)</th>
<th>% FO</th>
<th>LVMI</th>
<th>% BV- 2 hrs</th>
<th>% BV- 4 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No change/improved CI</strong></td>
<td>3024 ± 1507</td>
<td>52.2 ± 13.1</td>
<td>17.9 ± 3.1</td>
<td>4.6 ± 2.4</td>
<td>46.6 ± 17.2</td>
<td>7.6 ± 3*</td>
<td>12.5 ± 4.6*</td>
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<td>(n=10)</td>
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</tr>
<tr>
<td><strong>CI- worsened</strong></td>
<td>3539 ± 1279</td>
<td>56.4 ± 11.5</td>
<td>17.8 ± 4.5</td>
<td>5.3 ± 2.6</td>
<td>44.3 ± 16.5</td>
<td>13.2 ± 5.2*</td>
<td>17.6 ± 5.1*</td>
</tr>
<tr>
<td>(n=12)</td>
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</table>

Values expressed mean; *= p-value < 0.005
Results

No Change/Improved CI

Worsening CI

No Change/Improved CI

Worsening CI
Pediatric Myocardial Stunning

Changes of cardiac functions after hemodialysis session in pediatric patients with end-stage renal disease: conventional echocardiography and two-dimensional speckle tracking study

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Received: 13 August 2019 / Revised: 31 October 2019 / Accepted: 17 December 2019
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Pediatric Myocardial stunning

- June 2018-April 2019

- 40 (24 male) pediatric ESRD patients on chronic HD
  - Patients up to 18 years of age
  - On HD 3 times/week for at least 3 months

- Excluded patients with congenital heart disease, arrhythmia, or significant valve disorders
Pediatric Myocardial Stunning

• Echo performed pre and post dialysis session and included two-dimensional speckle tracking and assessed left ventricular strain.

• Changes occurred regardless of the presence of symptomatic hemodynamic compromise
Other organs (Brain)

Methods

• 97 adult patients (average age 59 years)

• Transcranial Doppler ultrasound measured cerebral arterial mean flow velocity

• Assessed cognitive function during, post-dialysis, and after 12 months of treatment

• Used brain MRI to assess white matter and atrophy
Results

• Cerebral arterial mean flow velocity declined significantly during dialysis and was correlated with intradialytic decline in cognitive function

• Combination of hemodynamic instability during HD and diminished cerebral autoregulation may lead to cerebral hypoperfusion and subsequent ischemic injury
Other organs (Gut)

• Intestinal perfusion drops acutely during dialysis (found using dynamic CT perfusion imaging).

• The degree to which perfusion fell was associated with the degree of systemic circulatory stress and the severity of HD-associated cardiac injury.
Other organs (Gut)

• Levels of endotoxin, a bacterial toxin found within the gut that translocates into the systemic circulation with gut injury, are massively elevated in those receiving chronic dialysis.
So now what???
Interventions

Results

Interventions

Results

Interventions

• Peritoneal dialysis

• 10 patients on PD; used serial echos to assess ejection fraction and regional systolic LV function
  - Only 1 patient had regional wall motion abnormalities
  - In contrast to HD, acute effects of PD did not result in subclinical myocardial ischemia

Interventions

Results


Figure 3. | Trial outcomes expressed as standardized effect sizes with 95% confidence intervals. The mean changes from Table 2 are divided by the pooled SD of the variable at baseline. LV, left ventricular; LVEF, left ventricular ejection fraction.
Interventions

Results

Conclusion

• Conventional methods currently used for assisting fluid removal in HD are inadequate to assess hemodynamic changes.

• Prescriptions with individualized rate of fluid removal, temperatures, & noninvasive CV monitors are urgently needed to manage pediatric patients during HD treatments.

• More studies are needed in children on ESRD to assess interventions for prevention of organ stunning.
Thank you

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References


