Method and duration of hemodialysis

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How to improve outcomes in hemodialysis

- After a change in payment policy in the US, number of nephrologist visits per month markedly increases in HD pts

Results: In the comparison of 12 months before and 7 months after,

- They concluded that "no clinically important change in surrogate markers despite doubling of nephrologist visit number per month"

Do we really have efficient tools to improve outcomes in hemodialysis?

- **ACE-I**: No survival benefit – FOSIDIAL
- **Statins**: No survival benefit – 4D, AURORA
- **Non-Ca based PO\(4\) binders**: No better PO\(4\) control, no survival benefit – CARE, D-COR
- **Erythropoietin**: Good or bad? – CHOIR, CREATE
- **Folic acid**: No survival benefit – HOST
- **High flux membrane, high blood flow**: No survival benefit – HEMO (advantage only in some subgroups, MPO)
- **Ultra-pure dialysate**: Unknown
- **Hemodiafiltration**: Unknown
Any missing ones?

- MORE INTENSIVE DIALYSIS
- SALT RESTRICTION & VOLUME CONTROL
SALT RESTRICTION & VOLUME CONTROL
50-90% of dialysis patients are hypertensive despite several anti-hypertensive medications.

Whereas almost no hypertension in early years of HD.

- Blood pressure was normal in 91% of patients without anti-hypertensive medications in 1960s (9 reports).

What has changed in the last 30 years?

- Duration of HD sessions ↓
- Dialysate Na concentration ↑
- Dietary Na intake ↑
- Use of anti-HT medication ↑
- Blood pressure ↑

* Anti-HTN= % of patients using antihypertensive medications

Charra B, Hemodial Int 2007
Salt intake-interdialytic weight gain and mortality

- Higher IDWG & overall mortality in diabetics
  
  Kimmel PL, Kidney Int 2000

- Higher left atrial volume & mortality in HD patients
  
  Tripepi G, J Hypertens 2006

- Higher UF rate & overall mortality
  
  Movilli E, Nephrol Dial Transplant 2007

- Higher IDWG & CV and overall mortality
  
  Kalantar-Zadeh K, Circulation 2009

- Predictive role of LA volume for mortality is dependent on IDWG
  
  Ozdogan O, Am Heart J 2010
Implementation of “volume control strategy” in Ege University Dialysis Center

Before 1993,

- 65% of patients were using anti-hypertensive medications
- Interdialytic weight gain over 3 kg
- Heart failure frequent, cardiothoracic index above 0.5 in 75%
- Intradialytic hypotension and cramps frequent
- Some patients diagnosed as uremic cardiomyopathy
- Many patients requested to stop earlier dialysis because of hypotension and cramps in the last hours of dialysis
Volume control policy implemented by Dr Evert J Dorhout Mees in Ege University

- 12 - 15 hours HD per week
- Dialysate Na concentration 135-138 mmol/L
- Discontinuation of anti-hypertensive medications
- **Strict dietary salt restriction** (as lower as possible with aim of 50 mmol/day) to reduce interdialytic weight gain below 2 kg
- Recommendation for fluid intake: “**not to drink more or less than thirst feeling indicated**”
• Insistent UF for dry weight reduction until blood pressure becomes below 140/90 mm Hg and cardiothoracic index below 0.50 (CTi: calculated as the largest inner diameter of the rib cage divided by the largest diameter of the heart shadow on the chest X-ray)

• If needed, temporarily additional UF sessions

• If in doubt for renin-dependent hypertension, if BP becomes normal after a test dose of 25 mg PO captopril, start an ACE-I
The results of switch from conventional approach to volume control strategy

- **67 hypertensive HD patients**, stop anti-hypertensive medications, insistent UF, dietary salt restriction; **4 years follow-up**
- At the end, only 4% in need of anti-HT medication
- No edema, no heart failure
- Intradialytic hypotension and cramps decreased
- Hemoglobin and serum albumin levels increased

Ozkahya M, Am J Kidney Dis 1999
Regression of left ventricular hypertrophy with volume control

- Two echocardiographies in 15 prevalent HD patients with a mean interval of 37±11 months after implementation of volume control policy

<table>
<thead>
<tr>
<th></th>
<th>First</th>
<th>Second</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP (mmHg)</td>
<td>136 11</td>
<td>101 14</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>119 8</td>
<td>82 12</td>
</tr>
<tr>
<td>CTi</td>
<td>0.48 0.03</td>
<td>0.43 0.04</td>
</tr>
<tr>
<td>Left atrial diameter (mm/m²)</td>
<td>22.5 3.1</td>
<td>19.9 4.4</td>
</tr>
<tr>
<td>LV mass index (g/m²)</td>
<td>175 60</td>
<td>105 11</td>
</tr>
</tbody>
</table>

Ozkahya M, Nephrol Dial Transplant 1998
Treatment of paradoxical hypertension by ultrafiltration

- Seven patients with paradoxical hypertension who were not responsive to medications (no edema but cardiac dilatation)

- After reduction of body weight below a threshold value (6.7 ± 3.0 kg), paradoxical BP increases during HD disappeared

- CTi decreased; EF increased; valvular regurgitations regressed; serum albumin increased

Cirit M, Nephrol Dial Transplant 1998
Disappearance of mitral and tricuspid regurgitation by ultrafiltration in HD patients

- 21 patients with valvular insufficiency (no sign of heart failure but cardiomegaly)
- Dry weight reduction with slow ultrafiltration in long term (months) (mean decrease in body-weight 5.4 ± 2.7 kg)

<table>
<thead>
<tr>
<th></th>
<th>Before UF</th>
<th>After UF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitral regurgitation (n)</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Tricuspid regurgitation (n)</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>Mean arterial pressure (mmHg)</td>
<td>126 ± 15</td>
<td>95 ± 11</td>
</tr>
<tr>
<td>Cardio-thoracic index (%)</td>
<td>57</td>
<td>47</td>
</tr>
<tr>
<td>Mitral annular diameter (mm/m²)</td>
<td>23</td>
<td>19</td>
</tr>
<tr>
<td>Left ventricul systolic diameter (mm/m²)</td>
<td>25 ± 5</td>
<td>21 ± 5</td>
</tr>
<tr>
<td>Left ventricul end-diastolic diameter (mm/m²)</td>
<td>31 ± 5</td>
<td>27 ± 5</td>
</tr>
</tbody>
</table>

Cirit M, Nephrol Dial Transplant 1998
Hypervolemic hemodialysis patients with low ejection fraction

- 12 prevalent HD patients with heart failure who had ejection fraction ≤45% (mean EF 31.9%) (mean age 43.9 years)

- 7 of 12 were diabetics

- BP low in half of them, valvular regurgitation present in all cases

**Treatment**

- Prolonged sessions or additional isolated UF sessions

- Slow UF (0.2–0.5 L/h)

- Mean decrease in body weight 12–10 kg (corresponding to 19% of baseline body weight) in 20-120 days

Toz H, Hemodial Int 2007
Significant improvement of low ejection fraction by ultrafiltration

- Heart failure findings disappeared in all patients
- Ejection fraction increased in all, from 31.9% to 50.9%
- BP increased in cases with low BP at baseline
- Valvular regurgitations disappeared or improved

Toz H, Hemodial Int 2007
Relationship between blood pressure and mortality in patients treated with volume control policy

- Patients with SBP between 101-110 mmHg had lowest mortality rate

Relationship between overhydration determined by chest x-ray and survival

Ozkahya M, Nephrol Dial Transplant 2006
# Independent predictors of mortality

<table>
<thead>
<tr>
<th></th>
<th>Risk Ratio</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age at start of HD</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;45 years</td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥45 years</td>
<td>5.01</td>
<td>1.98–12.67</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>SBP in follow up (mmHg)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100–130</td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;100</td>
<td>1.37</td>
<td>0.57–3.28</td>
<td>0.472</td>
</tr>
<tr>
<td>130–140</td>
<td>1.90</td>
<td>0.83–4.35</td>
<td>0.125</td>
</tr>
<tr>
<td>&gt;140</td>
<td>10.33</td>
<td>3.87–27.60</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>CTI in follow-up</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥&lt;0.48</td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥0.48</td>
<td>3.84</td>
<td>2.05–7.18</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

A cross-sectional study

- Comparison of the two dialysis centers regarding BP and cardiac geometry and functions
- Center A practiced volume control strategy, Center B anti-hypertensive medication-based strategy

<table>
<thead>
<tr>
<th></th>
<th>Center A (n: 190)</th>
<th>Center B (n: 204)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-hypertensive use (%)</td>
<td>7</td>
<td>42</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>IDWG (kg)</td>
<td>2.29</td>
<td>0.83</td>
<td>3.31</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>126</td>
<td>15</td>
<td>126</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>75</td>
<td>12</td>
<td>76</td>
</tr>
<tr>
<td>Intradialytic hypotension</td>
<td>11</td>
<td>27</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>episode per 100 sessions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- No difference regarding age, sex, diabetes, HD duration, dialysate composition

Kayikcioglu M, Nephrol Dial Transplant 2009
Cardiac aspect

- Despite similar BP control, volume control strategy is associated with
  - lesser cardiac dilatation
  - lower left ventricular mass
  - better preserved systolic and diastolic functions

* p<0.001
How to achieve successfull salt restriction?

- Are physicians convinced on the followings?
  - Salt intake leads to irresistible thirst and fluid intake
  - **Interdialytic weight gain is due to salt intake not water intake** (predialysis serum Na <130 mmol/L in only 0.3% of 7179 HD patients with normoglycemia)
  - **Intradialytic hypotension does not indicate that dry weight has been reached but an ultrafiltration rate higher than refill rate**
  - Do not forget that nurses who are the key persons for success must be convinced
Large differences of IDWG in the same country: Determinant role of dedicated health professionals

Proportion of patients with a ratio of IDWG/post-HD body weight below 3.5% in 50 HD Clinics in Turkey (23.8 - 88%)

Located in a highest salt consumed region of the country
Patients and their families

- How can we help our patients for this “addiction”?  
  — To tell these facts again and again  
  — To talk their family members  
  — To explain that adaptation to salt-free diet takes approximately one month (if he/she does not consume salty food in this period, then salt sensing of his/her tongue will be changed)  
  — To organize common information and discussion sessions  
  — To provide opportunities for compliant patients to share their positive experiences with other patients
Dietary recommendations

• In our country-our condition, we suggest:
  • No salt during cooking and eating
  • Salt-free bread
  • Diminish to consume processed food
• If it is an obligation to consume processed food,
  • Solution is more difficult
  • To find / prefer salt-poor products

• GOVERNMENTS ARE EXPECTED TO GRADUALLY RESTRICT SALT CONTENT OF FOODS
Conclusion

• Hypertension can be treated by volume control policy in patients treated with conventional hemodialysis regimen without anti-hypertensive medications.

• Overhydration even in the absence of hypertension is important and should be treated.

• Dietary salt restriction is essential and it can be achieved.
DURATION OF HEMODIALYSIS
History

- In the early era of chronic dialysis with 20-40 h/week HD
  - Excellent BP control, rare intradialytic BP drop
  - Satisfactory nutritional status
  - Sufficient RBC production
  - Nearly full rehabilitation, almost no neuropathy

- Later…
Short dialysis

- “Intensive utilisation of a dialysis unit”
  - From 27 hour/week in 1971 to 12 hour/week in 1972
  - *Successful adaptation, similar biochemical results except phosphate*
    

- Short dialysis schedules – “*Finally ready to become a routine?*”

  Proc Eur Dial Transplant Assoc 1973; 10: 342-8

  - Although “*bilateral nephrectomy is required in 2 cases for BP control!*”
Why dialyze more than 6 hours a week?
Rotellar E, ASAIO Trans 1985; 31:538

How long should it be? Need for a scale?

“God sent Kt/V for short hemodialysis”
Twardowski ZJ, University of Missouri

Despite presence of hypertension, hyperphosphatemia, anemia, “dialysis is adequate if Kt/V is above …”

And now we face:
Problems in patients treated with three times weekly four-hour hemodialysis

- High mortality and morbidity, low QOL
- Numerous troubles
  - High/low BP, LV hypertrophy, heart failure, arrhythmia
  - Anemia, malnutrition, inflammation
  - Hyperphosphatemia, vascular calcification

USRDS, Am J Kidney Dis 2003; 42 (Suppl 5): S103

- Introduction of several medications to solve these problems (Epo, P-binders, ACE-I, carniten, Na-modelling, gabapentin, etc)
- Extra cost (equal to 1/4 to 1/2 of dialysis cost)
- No survival benefit with these medications
## Clinical benefits of intensive HD

<table>
<thead>
<tr>
<th></th>
<th>Nocturnal HD</th>
<th>Short daily HD</th>
</tr>
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<tbody>
<tr>
<td>Blood pressure control</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Left ventricle hypertrophy</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>LV systolic function</td>
<td>+++</td>
<td>Not shown</td>
</tr>
<tr>
<td>Arterial compliance</td>
<td>+++</td>
<td>Not shown</td>
</tr>
<tr>
<td>Sleep apnea</td>
<td>Correction</td>
<td>Not shown</td>
</tr>
<tr>
<td>Cardiac autonomic abnormalities</td>
<td>Restoration</td>
<td>Not shown</td>
</tr>
<tr>
<td>Phosphate control</td>
<td>+++</td>
<td>Depends on duration</td>
</tr>
<tr>
<td>Anemia</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Malnutrition</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Inflammation</td>
<td>CRP and IL-6 ↓</td>
<td>CRP ↓</td>
</tr>
<tr>
<td>Cognitive function</td>
<td>+</td>
<td>Not shown</td>
</tr>
<tr>
<td>Fertility</td>
<td>++</td>
<td>Not shown</td>
</tr>
</tbody>
</table>

*Perl J, Am J Kidney Dis 2009*
Survival in NHD similar to cadaveric RTx

Pauly RP, Nephrol Dial Transplant 2009
Best survival data with three times weekly HD from Tassin: 8-h in-center HD
- Excellent patient survival (5-year survival 87%)
- Very few hypertension, good phosphate control, less anemia

Kidney Int 1992; 41: 1286

No prospective study to compare hemodialysis regimens applied in the past and now

Frequent Hemodialysis Network randomized trials: conventional HD versus in-center short daily HD and versus home nocturnal HD

Suri RS, Kidney Int 2007
Long Dialysis Study

Prospective, matched-controlled study to compare 8-h and 4-h in-center HD; follow-up one year

ClinicalTrials.gov Identifier: NCT00413803

- 224 prevalent conventional HD patients were assigned to 8-h three times weekly in-center nocturnal HD (NHD) and

- 224 age-, sex-, diabetic status-, and HD vintage-matched control cases to 4-h conventional HD (CHD)

- No difference in baseline parameters
<table>
<thead>
<tr>
<th></th>
<th>NHD (n: 224)</th>
<th>CHD (n: 224)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>45 ± 12</td>
<td>45 ± 12</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td>32%</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>HD vintage (months)</td>
<td>58 ± 44</td>
<td>58 ± 44</td>
</tr>
<tr>
<td>Duration of HD session (min)</td>
<td>455 ± 20 *</td>
<td>236 ± 8</td>
</tr>
<tr>
<td>Blood flow (ml/min)</td>
<td>240 ± 36 *</td>
<td>291 ± 31</td>
</tr>
</tbody>
</table>

Time-averaged data; * p<0.0001
# Overall mortality

<table>
<thead>
<tr>
<th></th>
<th>NHD</th>
<th>CHD</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>12 month-survival (%)</strong></td>
<td>98.7</td>
<td>93.8</td>
<td>0.009</td>
</tr>
<tr>
<td><strong>Death rate (n/100-pt-yr)</strong></td>
<td>1.29</td>
<td>6.03</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

- **Multivariate analysis**

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<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NHD vs CHD</strong></td>
<td>0.23 (0.06-0.80)</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td><strong>Age (per 1 year)</strong></td>
<td>1.07 (1.03-1.11)</td>
<td>&lt;0.001</td>
<td></td>
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</table>

* Adjusted for age, gender, diabetes, and HD duration

Model Chi-square: 24.3, p < 0.001
### Time-averaged laboratory values

<table>
<thead>
<tr>
<th></th>
<th>NHD</th>
<th>CHD</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>spKt/V</td>
<td>1.86</td>
<td>1.38</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pre-dialysis K (mEq/L)</td>
<td>5.00</td>
<td>5.11</td>
<td>0.042</td>
</tr>
<tr>
<td>Phosphate (mg/dl)</td>
<td>3.89</td>
<td>4.95</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CaxP product (mg^2/dl^2)</td>
<td>35.0</td>
<td>43.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>4.03</td>
<td>3.93</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td>174</td>
<td>166</td>
<td>0.040</td>
</tr>
<tr>
<td>Triglyceride (mg/dl)</td>
<td>210</td>
<td>181</td>
<td>0.021</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>11.8</td>
<td>11.5</td>
<td>0.030</td>
</tr>
<tr>
<td>Ferritin (ng/ml)</td>
<td>788</td>
<td>921</td>
<td>0.045</td>
</tr>
<tr>
<td>Transferrin saturation (%)</td>
<td>27</td>
<td>32</td>
<td>0.004</td>
</tr>
<tr>
<td>Bicarbonate (mEq/L)</td>
<td>23.8</td>
<td>23.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>hsCRP (mg/dl)</td>
<td>1.41</td>
<td>1.70</td>
<td>0.055</td>
</tr>
</tbody>
</table>

- Higher Kt/V, albumin, Hb, HCO$_3$, triglyceride, total cholesterol in NHD
- Lower K, PO$_4$, ferritin, transferrin saturation in NHD
- 73% less all-cause hospitalization rate in the NHD arm (p<0.05)
- Marked decrease in intradialytic hypotension episodes in the NHD group (p <0.01)
Blood pressure control

- No change in mean arterial BP in both arms
- Requirement of anti-hypertensive medication decreased from 24% to 8% in the NHD group
Nutritional status

- Increase in post-dialysis body weight in NHD group, with stable blood pressure (from 65.14 to 67.15 kg, p<0.001)
- Increase in serum albumin level (from 3.95 ± 0.29 to 4.10 ± 0.29 g/dL, p<0.0001)
Hemoglobin levels slightly increased in both arms (p<0.01)
Proportion of patients on Epo declined from 57 to 22% in the NHD group (p<0.0001)
- Serum P levels decreased from 4.59 ± 1.31 to 3.83 ± 1.2 mg/dl at 12th month in NHD patients (p<0.0001)
- Use of P-binder declined from 81 to 22% (72% reduction)
- Decrease in LA diameter in the NHD group (from 2.35 ± 0.40 mm/m² BSA to 2.17 ± 0.34, p<0.001)

- Regression in LV mass index in the NHD group (from 140 ± 44 g/m² BSA to 116 ± 34, p<0.001)
The effect of longer HD on progression of coronary artery calcification

- Two multi-slice CTs in 89 patients with an interval of 10 months (43 NHD, 46 CHD)
- Followed for at least 6 months in the Long Dialysis Study
- Baseline demographical, clinical, laboratory data similar
- In follow-up serum P, CaxP product, use of P-binder and BP medication were lower in the NHD group
Change in median CAC score in patients with baseline score >200

- Lower progression rate with NHD in patients with moderate to severe vascular calcification

- Serum phosphate was predictor for CAC progression (Exp-B 2.05, 95% CI 1.46-2.90, p <0.001)
The effect of longer HD on arterial stiffness

- Pulse wave analysis and pulse wave velocity (from carotid to radial arteries) in 115 patients at baseline and 12 months (*AtCor®, PWV Inc., Westmead, Sydney, Australia*) (55 NHD, 60 CHD)
- Baseline demographical, clinical, laboratory data similar
- In follow-up serum P and CaXP product were lower in the NHD group
Augmentation index

- Alx increased in CHD arm, slightly decreased in NHD
- Change in Alx significantly different between two arms
- Serum P predictor for delta Alx ($\beta$-coefficient 0.349, $t$ 2.58, $p < 0.01$)
Pulse wave velocity decreased in the NHD group.
Diastolic dysfunction assessed by “ejection duration” improved in the NHD group.

Serum P was predictor for change in ejection duration ($\beta$-coefficient 0.415, $t$ 3.25, $p <0.01$)
Subendocardial perfusion

- Subendocardial perfusion reflected by “subendocardial viability ratio” increased in NHD
- Predictors for improvement were lower CRP and NHD (β-coefficient -0.397, t -3.45, p <0.01) (β-coefficient 0.314, t 2.70, p <0.01)
Multi-frequency bio-impedance analysis in 122 patients at baseline and 12th month (5, 50, 100, 200 kHz) (62 NHD, 60 CHD)

Baseline demographical, clinical, laboratory data similar

In follow-up, higher eKt/V and serum albumin, lower serum P and hsCRP in the NHD arm
Extracellular fluid volume measured by bio-impedance analysis

- ECV decreased in the NHD group, increased in the CHD group
Body fat mass and dry lean mass measured by bio-impedance analysis

- Increase in body fat mass and dry lean mass in the NHD group

* p<0.01

* p<0.05
The effect of longer HD on ventricular arrhythmias

- Holter ECG in 60 patients at baseline and at 3rd month; midweek 48-h recording (30 NHD, 30 CHD) (mean duration 2714 60 min)
- Baseline demographical, clinical, laboratory data similar; EF and LVMI not different
- In follow-up, lower use of anti-hypertensive medication and hypotension episode in the NHD arm
### Premature ventricular ectopia

#### PVE (n/1000 HR/per period)

- Decrease in PVE at all time-points in the NHD group, no change in CHD patients
Conclusion

Implementation of longer HD sessions may improve several outcomes:

- Better phosphate control, slow down in progression of vascular calcification, improvement in arterial stiffness
- Better volume and blood pressure control, regression of cardiac enlargement and left ventricular hypertrophy
- Improvement in anemia, reduction of Epo requirement; decrease in ventricular arrhythmia
Conclusion

- Improvement in nutritional status
- Decrease in intradialytic complications and hospitalization
- Decrease in mortality
Limitations of the presented studies

- Non-randomized
- Relatively small numbers of study cases
- Relatively short follow-up
- Methods not most accurate ones (echo instead of MRI for LV geometry)
It seems that we have some effective but underutilized tools to improve cardiovascular outcomes in dialysis patients.

Problems are those:

Compared to drug studies, difficulties in conducting randomized studies on both subjects, which are asked by nephrology community to be convinced.

Both requires serious enforcement from not only nephrologists but also governmental health authorities.
Dialysis, as longer as possible

Salt, as lower as possible

Thank you