Gambro Corporate Education Session

39th EDTNA/ERCA International Conference
18th—21st September 2010, Dublin, Ireland
Welcome to Gambro Education Session

For over 45 years, Gambro has worked with dialysis specialists, pioneering new therapies for dialysis clinics and their patients. And why this constant commitment to provide you with innovative products and services?

Put simply, dialysis isn’t easy—and it is becoming more demanding and time-consuming with the increasing number of patients with extensive comorbidities. So now we have taken a major step toward easier and more effective dialysis care. We will continue to work with every dialysis professional to ensure you are able to give an individualized, quality-assured therapy program that delivers the prescribed treatment for each patient in every single session.

To do this, we will provide advanced biofeedback monitoring technologies aligned with easy-to-use dialysis machines, optimized for use with our dialyzer technologies and supported by our acclaimed Technical Service team. We will work with you to prove the economic value of this approach.

We’re proud to give you IQD —Individualized Quality-assured Dialysis.

Once again, very welcome to our Corporate Education Session and we hope you will enjoy it.
Susanne Ljungren  
Gambro, Sweden  
Registered nurse with a dialysis and midwifery background.  
Joined Gambro in 1995 and has been responsible for different systems and products over time.  
A special interest in education and training.

Raffaella Beltrandi  
S.Orsola Malpighi Hospital, Bologna, Italy  
A registered nurse with a background of respiratory intensive care.  
Has been working with dialysis in Italy for more than 14 years and recently spent 16 months in the dialysis unit at the Royal Berkshire Hospital in Reading, UK.  
Involved in education and training, last 8 years responsible for the training of new colleagues.  
A special interest in vascular access and the data collection on dialysis biofeedback systems.

Gunilla Andersson  
Gambro, Sweden  
A registered nurse with extensive experience of dialysis.  
Started at the University Hospital in Lund, Sweden, 1977 at the dialysis department.  
Joined Gambro in 1983 and has held a number of positions over the years where machine development has been a key element.  
A special interest in education and training activities.
Providing Individualized Quality-assured Dialysis

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Why should we consider individualized dialysis?

Susanne Ljunggren
Gambro, Sweden
Why should we consider individualized dialysis?

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The dialysis population is getting older

Cardio Vascular morbidity

Diabetes

Arrhythmia

Increasing age

“In this scenario, the nephrology community has to do its best in order to offer the best treatment options to these patients using a multifaceted approach.”

Locatelli et al, 2010

Dialysis population age by country

2007 prevalence data from the DOPPS observational study

Trends in ESRD prevalent counts per age group

France (9 out of 20 regions)
A recent example of comorbidities in prevalent European HD patients

Europe includes France, Germany, Italy, Spain, UK, Belgium, Sweden
2007 data from DOPPS Annual Data Report 2009

Individualized Dialysis – Diabetic patients

Diabetic dialysis patients is the largest and most rapidly growing patient group

End-stage renal disease
- appears as a late complication of diabetes

Special challenges in delivering dialysis to diabetic patients

Increased risk for intradialytic hypotensive episodes commonly leading to inadequate dialysis - missed dry weight and Kt/V target - and hypertension
Tool box options - Diabetes

On line Hemodiafiltration (HDF):
- Enhances intradialytic hemodynamic stability
- Improves solute removal – smaller and larger MW solutes
- Higher biocompatibility reducing bioactivation and subsequent inflammation

Hemocontrol:
- Enhances intradialytic hemodynamic stability
- Facilitates dry weight defining
- Maintaining the sodium balance

AFBK:
- Enhances intradialytic hemodynamic stability
- Reduces risk of arrhythmias
- Improves acid-base correction

On-line HDF (HemoDiaFiltration)

- Significantly increased ultrafiltration (20-30 L per treatment)
  ... balanced with on-line prepared substitution fluid of IV quality (3-filter system)
- Highly permeable membrane (high-flux dialyzer)
- Convection of large MW solutes and diffusion of small MW solutes
- Accurate ultrafiltration and substitution fluid flow rate control

Lower relative risk of mortality with higher convective volumes*

![Graph showing relative risk comparison between HD, HDF, Low efficiency HDF, and High efficiency HDF.]

* Adjusted for age, sex, time on dialysis, 14 summary comorbid conditions, weight, catheter use, Hb, albumin, nPCR, cholesterol, triglycerides, Kt/V, Epo, MCS and PCS

Individualized Dialysis – CV morbidity

Cardiovascular morbidity

Increasing age

Diabetes

Arrhythmia

CV morbidity is the most common cause of death in dialysis patients.
Cardiac effects associated with chronic renal failure

Increased prevalence of:
• Coronary artery disease (CAD)
• Congestive heart failure (CHF)
• Left ventricular hypertrophy (LVH)
• Myocardial ischaemia (MI)

Patients with severe chronic kidney disease have a 10- to 20-fold increased risk of cardiac death compared to the general population.

Dialysis patients and CV morbidity
- DOPPS data from 2007

Special considerations in delivering dialysis to patients with CV morbidity

Tool box options – CV morbidity

On line HDF:
• Enhances intradialytic hemodynamic stability
• Improves solute removal – smaller and larger MW solutes
• Higher biocompatibility reducing bioactivation and subsequent inflammation

Hemocontrol
• Enhances intradialytic hemodynamic stability
• Facilitates dry weight define
• Maintaining the sodium balance

AF/BK
• Enhances intradialytic hemodynamic stability
• Reduces risk of arrhythmias
• Improves acid-base correction
HEMOCRITICAL

Managing the dialysis fluid sodium level and UFR to promote plasma refilling

![Graph showing continuous adaptation of UF rate and dialysis fluid sodium concentration to keep the blood volume variation within a physiological range and near the ideal trajectory.]

Control BV reduction to improve blood pressure stability

![Bar chart showing frequency of hypotension percentage reduction with HEMOCRITICAL and Standard HD.](chart)

Ref: Santoro et al. Kidney Int., 2002

HD-induced left ventricular dysfunction with regional wall motion abnormalities

![Images comparing pre-dialysis, end of dialysis, and 30 min post dialysis for Standard HD and HEMOCRITICAL HD.](image)

Ref: Selby et al. JND, 2006

Individualized Dialysis - Arrhythmia

Increasing age, Diabetes, Cardiovascular morbidity.

There is a strong link between underlying cardiac disease and increased risk of arrhythmias.
Arrhytmia in dialysis patients - underlying causes

- Diabetes
- Anemia
- Hyper-parathyroidism
- Hypertension

Structural Heart Disease

Dialysis induced arrhythmias

Hyperkalemia

Clinical significant ventricular arrhythmias

Fluid overload

Metabolic acidosis

Electrolyte imbalances

Potassium changes during dialysis

Adapted from Santoro et al, NDT 2008

Tool box options - Arrhythmia

On line HDF:

- Enhances intradialytic hemodynamic stability
- Improves solute removal - smaller and larger MW solutes
- Higher biocompatibility reducing bioactivation and subsequent inflammation

Hemocontrol:

- Enhances intradialytic hemodynamic stability
- Facilitates dry weight define
- Maintaining sodium balance

AFBK:

- Enhances intradialytic hemodynamic stability
- Reduces risk of arrhythmias
- Improves acid-base correction

AFBK - Acetate Free Biofiltration with automatic [K+] profiling

- Diffusive-convective treatment
- Dialysis fluid free of any buffer substance
- High volume of buffer given as an intravenous infusion
- Potassium profiling - exponential decreasing
- Highly biocompatible membrane
Plasma [K+] during HD in dialysis-sensitive patients

HD increases arrhythmogenic activity in the interdialytic phase

Individualized dialysis - summary

- Minimize the risk of intra-dialytic hypotensive episodes that increase the risk for ischemic stress to the heart that can provoke cardiac arrest
- Avoid excessive fluid overload and control sodium balance to limit hypertension and reduce the strain to the heart
- Avoid rapid potassium shifts that may provoke cardiac arrhythmias during and after dialysis

Delivering individualized hemodialysis in a complex dialysis unit

Raffaella Beltrandi
S.Orsola Malpighi Hospital,
Bologna, Italy
The Malpighi Hospital Dialysis Unit

- # of clinicians: 4
- # of nurses: 40
- # of stations in the unit: 23
- # of chronic patients: 124 (6 month time)
- # of acute in-patients: 64 (6 month time)

We provide dialysis treatment to any kind of patients:

- Chronic and acute patients
- On site intermittent treatment
- On site continuous treatment
- On site treatment to those acute patients who can’t be moved from their unit (CSICU, OLT, CICU, PICU)
- Total in last year: 1421
- 2010 first 6 months: 920

The Malpighi Hospital Dialysis Unit Patients

<table>
<thead>
<tr>
<th>Patients</th>
<th>Treatments</th>
<th>Quality assurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age: 68 years</td>
<td>HD treatments: 55%</td>
<td>Dialysis dose (Kt/V)</td>
</tr>
<tr>
<td>Mean Dialysis vintage: 7 years</td>
<td>On-line HDF treatments: 30%</td>
<td>Body weight assessment (BIA)</td>
</tr>
<tr>
<td>Comorbidity</td>
<td>acetate free biofiltration treatments: 10%</td>
<td>Venous pressure hourly</td>
</tr>
<tr>
<td>Diabetes 20%</td>
<td>Acetate free biofiltration treatments: 14%</td>
<td>Vascular Access for early detection of flow decrease</td>
</tr>
<tr>
<td>Peripheral vascular disease 22%</td>
<td>Hemocoustrol treatments: 10%</td>
<td>Hemocontrol treatments both with HD or Acetate Free Biofiltration</td>
</tr>
<tr>
<td>Coronary artery disease 16%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure 7%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Malpighi Hospital Dialysis Unit: increasing presence of technology
Critical patients and dialysis treatments

- Diabetic patients with high glucose level and high weight increase, unstable blood pressure → Acetate Free Biofiltration
- Patients with hypotension → Acetate Free Biofiltration with Blood Volume Tracking System (Hemocontrol)
- Patients with electrolyte imbalance, or hyperkalemia → Acetate Free Biofiltration with potassium profile
- Patients with high life expectancy → On line HDF with Ultracontrol biofeedback

Acetate Free Biofiltration (AFB)

- Infusion of sodium bicarbonate in post dialution
  concentration 145-167 mmol/l
  infusion rate 1.6-2.5 l/h
- Customized bicarbonate infusion, depending on treatment and patient parameters
- Single concentrate for a buffer-free dialysate, does not contain any acetate or bicarbonate

Clinical case #1 - Acetate Free Biofiltration with Blood Volume Tracking System

Patient: P.T.
Age: 85 years
Sex: Female
Dialysis vintage: 2 years
Comorbidity: Hypertensive ESRD, Cardiovascular instability, Karnofsky 80, Charlson 8

Standing hypotension after the sessions
Critical patients and dialysis treatments

- Diabetic patients with high glucose level and high weight increase, unstable blood pressure → Acetate Free Biofiltration
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- Patients with high life expectancy → On line HDF with Ultracontrol biofeedback

Blood Volume Tracking system

Profile of the dialysis fluid sodium concentration and ultrafiltration flow rate (UF Rate), according to the patient prescription and the relative blood volume changes.

Previous treatment until 2009

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Acetate Free Biofiltration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular access</td>
<td>FAV</td>
</tr>
<tr>
<td>Prescribed treatment time</td>
<td>4 h</td>
</tr>
<tr>
<td>Prescribed blood flow rate</td>
<td>250 ml/min</td>
</tr>
<tr>
<td>Dry weight</td>
<td>64.5 kg</td>
</tr>
<tr>
<td>Mean TWL</td>
<td>2.6 ± 0.33 litres</td>
</tr>
<tr>
<td>UF rate</td>
<td>0.65 ± 0.06 litres</td>
</tr>
<tr>
<td>HCO3- infusion rate</td>
<td>2.2</td>
</tr>
<tr>
<td>Na+</td>
<td>140</td>
</tr>
<tr>
<td>Filter</td>
<td>AN69 ST membrane</td>
</tr>
<tr>
<td>Na+ or UF Profile</td>
<td>No profiles</td>
</tr>
</tbody>
</table>

Lying Systolic Blood Pressure trend on AFB treatments - 6 treatments

Several standing hypotension after the treatment → Trendelenburg and drugs intervention to increase the blood pressure
Clinical case #2 - Acetate Free Biofiltration with Potassium Profiling

Patient: B.L.
Age: 81
Sex: Male
Dialysis vintage: 8 months
Comorbidity: Diabetes, peripheral and central vascular disease, cardiopathy treated with many angioplasty and stenting, AMI (acute myocardial infarction), hypertension, prosthetic mitral valve

Acetate Free Biofiltration with Blood Volume Tracking system from 2010

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Acetate Free Biofiltration with Blood Volume Tracking system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular access</td>
<td>FAV</td>
</tr>
<tr>
<td>Prescribed treatment time</td>
<td>4 h</td>
</tr>
<tr>
<td>Prescribed blood flow rate</td>
<td>300 ml/min</td>
</tr>
<tr>
<td>Dry weight</td>
<td>64.5 kg → 64.7 kg</td>
</tr>
<tr>
<td>Mean TWL</td>
<td>1.7 ± 0.4 litres</td>
</tr>
<tr>
<td>HCO₃ infusion rate</td>
<td>2.4</td>
</tr>
<tr>
<td>Filter</td>
<td>Xylenon ST membrane</td>
</tr>
<tr>
<td>Na⁺ or UF Profile</td>
<td>Both, Na⁺ and UF rate automatic profiles according to Blood Volume</td>
</tr>
</tbody>
</table>

Systolic Blood Pressure trend, after dry weight change - 6 treatments

No more standing hypotension after Hemocontrol treatment and corrected dry weight

Dry weight adjustment on AFB with Hemocontrol

The dry weight has been increased by 0.2 Kg → no more hypotension at all
Acetate Free Biofiltration with constant K\(^+\) setting until June 2010

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Acetate Free Biofiltration with constant K(^+) setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular access</td>
<td>CVC</td>
</tr>
<tr>
<td>Prescribed treatment time</td>
<td>3.5 h</td>
</tr>
<tr>
<td>Prescribed blood flow rate</td>
<td>300 ml/min</td>
</tr>
<tr>
<td>Filter</td>
<td>AN69 ST membrane</td>
</tr>
<tr>
<td>Dry weight</td>
<td>63.3 kg</td>
</tr>
<tr>
<td>TWL</td>
<td>3.5 liters</td>
</tr>
<tr>
<td>HCO(_3) infusion rate</td>
<td>2.2</td>
</tr>
<tr>
<td>Na(^+)</td>
<td>139</td>
</tr>
<tr>
<td>K(^+) setting</td>
<td>3.5 mEq/l, constant</td>
</tr>
</tbody>
</table>

Critical patients and dialysis treatments

- Diabetic patients with high glucose level and high weight increase, unstable blood pressure → Acetate Free Biofiltration
- Patients with hypotension → Acetate Free Biofiltration with Blood Volume Tracking System (Hemocontrol)
- Patients with electrolyte imbalance, or hyperkalemia → Acetate Free Biofiltration with potassium profile
- Patients with high life expectancy → On line HDF with Ultracontrol biofeedback

Acetate Free Biofiltration with K\(^+\) profile from July 2010

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Acetate Free Biofiltration with K(^+) profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prescribed treatment time</td>
<td>3.5 h</td>
</tr>
<tr>
<td>Prescribed blood flow rate</td>
<td>300 ml/min</td>
</tr>
<tr>
<td>Filter</td>
<td>AN69 ST membrane</td>
</tr>
<tr>
<td>HCO(_3) infusion rate</td>
<td>2.2</td>
</tr>
<tr>
<td>Na(^+)</td>
<td>139</td>
</tr>
<tr>
<td>TWL</td>
<td>2.8 liters</td>
</tr>
<tr>
<td>K(^+) setting</td>
<td>Mean K(^+) 3.5 mEq/l, K(^+) profile</td>
</tr>
</tbody>
</table>

Acetate Free Biofiltration with potassium profiling

To avoid problems of hyperkalemia or electrolyte imbalance, the Acetate Free Biofiltration could be performed with potassium profiling

<table>
<thead>
<tr>
<th>Blood K(^+) level</th>
<th>Dialysis bath K(^+) level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Time</td>
</tr>
</tbody>
</table>
Plasma K⁺ reduction: AFB vs. AFBK
Comparison between 3 AFB and 3 AFBK treatments

Mean trend

<table>
<thead>
<tr>
<th></th>
<th>AFB 3.5 K⁺ constant</th>
<th>AFBK 3.5 K⁺ profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning K⁺</td>
<td>4.1</td>
<td>3.4</td>
</tr>
<tr>
<td>After 30'</td>
<td>5.2</td>
<td>4.7</td>
</tr>
<tr>
<td>After 60'</td>
<td>4.3</td>
<td>4.5</td>
</tr>
<tr>
<td>After 120'</td>
<td>4.9</td>
<td>4.9</td>
</tr>
<tr>
<td>Post HD.</td>
<td>5.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Systolic blood pressure trend AFB vs. AFBK

<table>
<thead>
<tr>
<th></th>
<th>AFB 3.5 K⁺ constant</th>
<th>AFBK 3.5 K⁺ profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning</td>
<td>137</td>
<td>150</td>
</tr>
<tr>
<td>1st hour</td>
<td>161</td>
<td>143.5</td>
</tr>
<tr>
<td>2nd hour</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>3rd hour</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Post Treatment</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

Heart rate trend AFB vs. AFBK

<table>
<thead>
<tr>
<th></th>
<th>AFB 3.5 K⁺ constant</th>
<th>AFBK 3.5 K⁺ profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>44</td>
<td>52</td>
</tr>
<tr>
<td>After 30'</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>After 60'</td>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td>After 120'</td>
<td>51</td>
<td>51</td>
</tr>
</tbody>
</table>
Clinical case #3 - on line HDF Ultracontrol

Patient: C.H.
Age: 43 years
Sex: female
Dialysis vintage: 1.5 year
Co-morbidity: Hypertensive ESRD

Relative young and lack of serious comorbidity

Standard HD treatment until March 2010

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Standard HD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Htc</td>
<td>32.5%</td>
</tr>
<tr>
<td>Vascular access</td>
<td>FAV with high venous pressure</td>
</tr>
<tr>
<td>Prescribed treatment time</td>
<td>4 h.</td>
</tr>
<tr>
<td>Prescribed blood flow rate</td>
<td>300 ml/min</td>
</tr>
<tr>
<td>Mean TWL</td>
<td>3.7 ± 0.3 litres</td>
</tr>
<tr>
<td>Na+</td>
<td>138 mmol/l</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>30 mmol/l</td>
</tr>
<tr>
<td>Filter</td>
<td>Polyflux</td>
</tr>
<tr>
<td>Number of treatments = 8</td>
<td></td>
</tr>
</tbody>
</table>

Critical patients and dialysis treatments

- Diabetic patients with high glucose level and high weight increase, unstable blood pressure → Acetate Free Biofiltration
- Patients with hypotension → Acetate Free Biofiltration with Blood Volume Tracking System (Hemocontrol)
- Patients with electrolyte imbalance, or hyperkalemia → Acetate Free Biofiltration with potassium profile
- Patients with high life expectancy → On line HDF with Ultracontrol biofeedback

On line HDF post dilution Ultracontrol from April 2010

<table>
<thead>
<tr>
<th>Treatment</th>
<th>On line HDF post dilution with Ultracontrol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Htc</td>
<td>32.5%</td>
</tr>
<tr>
<td>Vascular access</td>
<td>FAV with high venous pressure</td>
</tr>
<tr>
<td>Prescribed treatment time</td>
<td>4 h.</td>
</tr>
<tr>
<td>Prescribed blood flow rate</td>
<td>300 ml/min</td>
</tr>
<tr>
<td>Mean TWL</td>
<td>2.8 ± 0.8 litres</td>
</tr>
<tr>
<td>Na⁺</td>
<td>138 mmol/l</td>
</tr>
<tr>
<td>HCO₃⁻</td>
<td>30 mmol/l</td>
</tr>
<tr>
<td>Filter</td>
<td>AN 69 ST</td>
</tr>
<tr>
<td>Number of treatments = 8</td>
<td></td>
</tr>
</tbody>
</table>
Blood purification effects in on line HDF post dilution Ultracontrol

On line HDF – 8 treatments

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea (mg/dl)</td>
<td>30.4 ± 2.4</td>
</tr>
<tr>
<td>Kt/V</td>
<td>1.96 ± 0.09</td>
</tr>
<tr>
<td>Phosphate (mg/dl)</td>
<td>1.56 ± 0.04</td>
</tr>
</tbody>
</table>

Pre to post phosphate reduction in plasma level

Systolic Blood Pressure trend HD vs. on line HDF Ultracontrol - 8 treatments

The Ultracontrol system facilitates optimal convective volume automatically by means of biofeedback.

A TMP scan is performed at the beginning of each session, thereafter it regularly checks and adjusts TMP to reach the optimal convective volume for each treatment.

This gives the most efficient blood purification, removes the risk of TMP alarms and reduces the need for manual checks and interventions.
Conclusions

• The increasing presence of technology in the dialysis unit could help nurses to manage the dialysis treatments.

• It’s important to customize the dialysis treatment for each patient.

• Using the technology in the dialysis unit, we can save time for the patient care.

• Preventing the problem is better than waiting and solving it later, and it is often cheaper!
How can we assure delivery of quality dialysis

Gunilla Andersson
Gambro, Sweden
How can we assure delivery of quality dialysis

gunilla.andersson@gambro.com

Quality-assurance applied to dialysis

Plan - Prescribe the therapy
  • Consider the patient’s individual needs

Do - Deliver dialysis treatment
  • Implement prescription and avoid interruptions

Check - Response to dialysis treatment
  • Use monitoring devices and IT tools to gather key data

Act - Analyze and draw informed conclusions
  • If needed, adjust prescription for subsequent treatments

Consistent dialysis delivery to all patients, at all time

Clinic variability in delivering Kt/V
– a real-life example

Treatment dose OK?

On target

Insufficient treatment?

Inefficient use of resources and patient time?
Diascan quality control tool
– automatic on-line clearance check

Clearance assessment for every treatment

The science behind Diascan

- The Urea molecule (MW 60) is approximately the same size as sodium chloride (MW 58.5)
- Urea and sodium chloride are closely related in clearance characteristics
- Urea transfer can be derived from the measurement of sodium chloride transfer
- Sodium ions are available in the dialysis fluid
- The sodium ion concentration is easily measured with a conductivity cell

Ionic clearance vs. urea clearance
– corrected for cardio- pulmonary recirculation

Dialysis dose by Diascan, Kt or Kt/V

Kt = the volume cleared, in liters
Example:
250 ml/min for 240 min = 60000 ml = 60 L

Kt/V = the volume cleared divided by the patient’s estimated urea volume (V)
Example:
V = 40 L, then Kt/V = 60 / 40 = 1.5

Æ
Vascular access assessment

European Best Practice Guidelines on Vascular Access, 2007: guidelines 4.1 and 4.2:
- Nurses and medical staff should be involved in vein preservation and monitoring of the vascular access.

The ways to do it:
- Physical examination
- Follow arterial and venous circuit pressures
- On-line clearance in relation to effective blood flow rate
- Trend analysis over time
- Access flow measurements - to confirm deterioration of access functionality.

Example of a partial thrombosis in a central venous catheter

Example of arterial line kinking

Ionic clearance vs. blood flow rate

Clearance in relation to effective $Q_b$ gives relevant information on access functionality

- A 50% limit is easy to use
- At blood flow rates less than 300 ml/min, a limit of 55% or 60% may be more appropriate.
Ionic clearance / $Q_b$ vs. access flow

- 80%
- 60%
- 40%
- 20%

Mohan et al. ASAIO J 2010

Diascan - Reduced clearance is detected regardless of cause

- Poor vascular access
- Small needles
- Reversed needles

Co-current flows

Filter clotting

An IT Network Structure

- Exalis Terminals in the dialysis rooms
- Database Server
- Qcontrol Extractor

Examples of using IT systems to show trends in dialysis-related patient data
**Stable dialysis Kt delivery**
- one patient over 6 months

**Variable dialysis Kt delivery**
- one patient over 6 months

**Qcontrol compilation report**
- delivered Kt/V in all patients over 6 months

**Access problem revealed by decreasing clearance**
- one patient over 6 months
Intradialytic blood pressure recordings
-- one patient over 6 months

Dry weight in dialysis

One definition of many
“The lowest tolerated post dialysis weight achieved via gradual change in post dialysis weight at which there are minimal signs or symptoms of hypovolemia or hypervolemia.”
[Sinha and Agarwal 2009]

Importance
A correctly set dry weight implies:
• Less long term volume/pressure overload of the heart’s left ventricle
• Less hypertension and less need for anti-hypertensive medications

Blood volume in relation to fluid status

Ref: A.C. Guyton: Textbook of Medical Physiology

Hemoscan – automatic online blood volume monitoring

Non invasive blood volume monitoring
• A decrease in plasma water causes a relative increase in hemoglobin concentration i.e. less light is absorbed
• This increase in hemoglobin is displayed as a relative decrease in blood volume
In dialysis, if dry weight is adequately set

- Blood Volume (L)
- Body weight (Kg)
- Post-dialysis
- Pre-dialysis
- ΔBV 10%
- UF 3 L

In dialysis, if dry weight is set too high

- Blood Volume (L)
- Body weight (Kg)
- Post-dialysis
- Pre-dialysis
- ΔBV >>10%
- UF 3 L

In dialysis, if dry weight is set too low

- Blood Volume (L)
- Body weight (Kg)
- Post-dialysis
- Pre-dialysis
- ΔBV <<10%
- UF 3 L

Dry weight setting and blood volume change

<table>
<thead>
<tr>
<th>Dry weight setting</th>
<th>BV vs. UF volume</th>
<th>BV change</th>
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<tbody>
<tr>
<td>Adequate</td>
<td>BV is dependent of UFV</td>
<td>BV curve drops moderately</td>
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<tr>
<td>Too high = Fluid overload</td>
<td>BV is independent of UFV</td>
<td>BV curve is flat</td>
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<tr>
<td>Too low = Fluid depletion</td>
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<td>Intradialytic hypotension and other symptoms</td>
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Dry weight setting and blood volume change

- BV vs. UF volume
- BV change
- Adequate
- Too high = Fluid overload
- Too low = Fluid depletion
On-line treatment supervision

• Cross-analysis of key treatment parameters
• Real-time calculations (treatment trends, average values …)
• Un-optimized situations identified

Examples:
- BV is decreasing too rapidly
- Real blood flow is less than 90% of the blood pump speed
- Clearance is less than 55% of the blood flow
- Diffusion is too low in HDF

Individualized Quality-assured Dialysis

Therapies responding to individual needs
- Standard HD
- On-line HDF
- Hemocontrol
- AF/BK
- …

Quality control
- Ionic clearance measurement
- Blood volume reduction assessment
- Blood pressure recordings
- Circuit pressure recordings
- Smartscan supervision

Cardio Vascular morbidity

- Diabetes
- Arrhythmia
- Increasing age

"In this scenario, the nephrology community has to do its best in order to offer the best treatment options to these patients using a multifaceted approach." 
Locatelli et al, 2010
Because every patient is different …

We’ve developed Individualized Quality-assured Dialysis (IQD) tools to help you deliver the best care to every single patient, in every single session.

IQD tools let you choose the right therapy and adapt it to an individual patient’s needs. They give you confidence that the session is easily and effectively delivered and the target dose is consistently reached. They also help you keep staff happy and make the best use of the clinic’s resources.

IQD is all about making a difference in the daily lives of you and your patients.

Because every session is different …