

## Diascan for effective quality control of delivered dialysis dose

### Monitoring dialysis dose

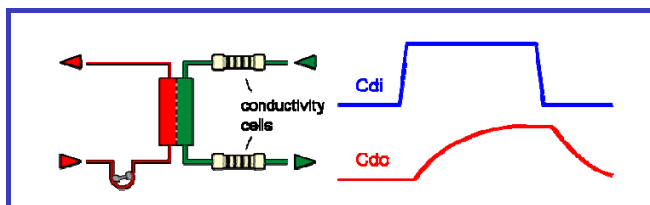
The most widely used dose parameters in dialysis are based on small solute removal, in spite of increasing evidence that also middle molecule weight uremic toxins are as important for the long-term outcome in chronic dialysis. Urea clearance (K) is the common efficiency parameter for small solutes, which when multiplied with the effective treatment time (t) converts into cleared volume. Normalizing to body size is mostly by V, the urea distribution volume, resulting in Kt/V as the normalized dose. Although its validity is time and again debated, Kt/V is seen as an important quality control parameter in chronic dialysis and targets for delivered Kt/V are given in many clinical guidelines.

### Blood based urea Kt/V

The Kt/V actually delivered can be calculated from blood urea measurements before and after dialysis. Simplified formulas are available that also considers urea removed by the ultrafiltered fluid as well as urea generated during treatment [1]. For practical reasons, though, blood based urea Kt/V evaluations are not frequently performed, but at most once monthly. Thus, in reality blood based urea Kt/V does not function as a quality control tool for each dialysis treatment.

### Dose monitoring by Diascan

The Diascan feature, which is built into the dialysis machine, calculates the effective 'conductivity clearance' during the dialysis. It works by intermittently creating in dialysis fluid a brief conductivity pulse and measuring the resulting conductivity in dialysate after passage through the dialyzer.



From these data the effective clearance of conductivity, i.e. the ionic dialysance, is calculated [2,3,4]. By integrating the results over time, Diascan provides regular updates on the effective dose delivered, i.e. K times t. As the measurement is automated, not leading to significant sodium gain, and not interfering with the diffusive processes in the dialyzer it can easily be applied for each dialysis treatment.

### Dialysance vs. clearance

The efficiency parameter delivered by Diascan is most accurately termed ionic dialysance [5]. While dialysance describes the inherent capability to transfer a solute between blood and dialysis fluid, clearance is frequently defined as the true efficiency by which the patient's blood is cleaned. Dialysance equals clearance only when the solute in question is absent in the fresh dialysis fluid, as is the case for urea. Dialysance is not affected by adding the solute to the fluid. Clearance on the other hand, by that definition, will be less when the solute is present on both sides of the dialysis membrane. For all practical purposes, however, we may choose to describe the Diascan parameter as 'ionic clearance'.

### Ionic clearance accurately estimates urea clearance

As the conductivity of dialysis fluid is mainly determined by its content of sodium, the ionic clearance determined by Diascan relates primarily to the transfer of sodium across the dialyzer membrane. As sodium closely resembles urea in diffusive and convective behavior, there is also a close agreement between ionic and urea clearance [6,7].

Mean difference (Diascan K – effective urea K<sup>1</sup>) = -2 ml/min (SD 18) [ref 6]

<sup>1</sup> dialysate side K corrected for cardiopulmonary recirculation

### Diascan presents the effective clearance

The ionic clearance revealed by conductivity measurements reflects the true efficiency of the dialysis process, at the current real blood and dialysis fluid flow rates in the dialyzer. It includes the effects of access and cardio-pulmonary recirculation [8]. Diascan K values are therefore lower than clearances measured at the dialyzer level from blood samples without considering recirculation effects. Clinically the Diascan K value is a more relevant measure of treatment efficiency.

### Setting the V for Diascan

Diascan cannot measure the urea distribution volume, but requires a manual input of V to calculate and show the delivered Kt/V. The V can be assessed from formal urea kinetics, but practically it is often estimated as the body water volume calculated from an anthropometrical formula. The Watson formulae are frequently used for adults [9], but has been found to slightly overestimate the true urea distribution volume

in ESRD patients [10,11]. Special adjustments are needed for amputees [12].

**Watson formulae:**

**Males**  $V = 0.336 \times W + 0.107 \times H - 0.095 \times A + 2.45$

**Females**  $V = 0.247 \times W + 0.107 \times H - 2.1$

where *V* is body water volume in liters, *W* is body weight in kg, *H* is height in cm, and *A* is age in years.

For children the Mellits-Cheek formulae may be used [13].

**Diascan Kt/V vs. blood urea spKt/V and eKt/V**

Blood urea based Kt/Vs may vary greatly depending on how the post-dialysis blood is sampled and what formula is used to calculate Kt/V. A single-pool Kt/V (spKt/V) results from an immediate post-dialysis blood sample and a standard formula. Adjusting for body fluid disequilibrium at treatment end and the rebound that follows, results in an equilibrated Kt/V (eKt/V). These values typically differ by close to 0.2 units [14].

Diascan Kt/V greatly depends on what *V* is entered for the calculation. When *V* is accurately determined from formal urea kinetics one should expect Diascan to deliver Kt/V values comparable to those achieved by the urea kinetic formula [15,16]. If *V* is estimated by a Watson formula Diascan Kt/V falls close to a blood urea eKt/V, on average [16]. For individual patients, though, the deviation may be significant.

eKt/V	1.19 ±0.21
Diascan Kt/V (V by UKM)	1.19 ±0.30
Diascan Kt/V (V by Watson)	1.12 ±0.21

Data (mean ± SD) from a comparative study in 61 patients where eKt/V was calculated from blood urea levels, and Diascan Kt/V was calculated using *V* by urea kinetic modeling (UKM) and *V* by Watson formulae. [16]

**Diascan to ensure quality in dialysis delivery**

A major benefit of applying Diascan measurements is to quickly identify problems leading to inadequate dialysis. A lower than expected *K*, and *Kt*, will result from inadvertent reversal of the access needles, access dysfunction, or co-current instead of counter-current flows in the dialyzer. By using Diascan data an attentive staff can spot such problems early in treatment and take timely remedial actions.

In stable conditions, without the type of problems mentioned above and with little variation in treated blood volume, the mean within-patient coefficient of variation for Diascan Kt/V has been found to be 5% [15].

**Summary**

The Diascan feature provides for each treatment an automated and reliable assessment of the delivered dialysis dose. Accurate setting of *V* is essential to compare to blood based urea eKt/V values.

**References**

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