**Blood Pump Speed vs. Actual or “Compensated” Blood Flow Rate**

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When setting the prescribed blood pump speed on a hemodialysis machine, the actual blood flow rate delivered is often less than what is prescribed. It has been difficult to accurately assess the actual blood flow rate that is achieved until recent improvements in technology that allow the dialysis machine to calculate this value internally. The actual or “compensated” blood flow rate displayed is a calculated blood flow rate. It reflects the actual rate at which blood is flowing through the cartridge blood tubing set. This calculated value takes into account the blood pump speed and the negative arterial pressure within the system (Gambro Lundia AB, 2004). With the purchase of Gambro Phoenix dialysis machines, these new technologies became available for our staff to use.

Our initial experience demonstrated that the compensated blood flow rate displayed was consistently lower than the displayed blood pump speed, with the difference between the two values increasing as the blood pump speed was increased. A Continuous Quality Improvement (CQI) study was designed to utilize two of this machine’s new features: compensated blood flow rate and online ionic Kt/V. The purpose of this study was to determine if there was a statistically significant difference in Kt/V when the blood flow rate prescribed by the nephrologist was set as the blood pump speed compared to being set as the compensated blood flow rate.

**Goal**
To describe a study comparing methods of setting blood flow rate delivered by a dialysis machine.

**Objectives**
1. Outline problems encountered in determining blood flow rate delivery by dialysis machines.
2. Describe studies done on determining differences in the methods of setting blood flow rate.
3. Summarize the results of the study described to determine differences in the methods of setting blood flow rate.

**Background**
When the nephrologist prescribes the blood flow rate for a patient’s hemodialysis treatment, the staff sets the blood pump speed to the prescribed level. However, the actual blood flow rate delivered by the blood pump has been found to be less than the blood pump speed setting when measured by volumetric or ultrasonic flow probe methods (Depner, Rizwan & Stasi, 1990; Hoenich, 1998; Sands, Glidden, Jacavage, & Jones, 1996; Schmidt, Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kurtz, & McCarthy, 1991; Schneipp, Kur...
Stragier, Wenderickx, & Jadoul, 1996; Teruel et al., 2000). This discrepancy can be attributed to several problems. Partial collapse of the blood pump tubing segment by the roller pump results in an increased negative arterial pressure and decreased total area in the tubing segment, causing a smaller volume of blood to be delivered. Schmidt et al. (1991) demonstrated, with timed outflow measurements using four different blood pumps and blood lines from three different manufacturers, that with increasing negative arterial pressure during a hemodialysis treatment, the actual blood flow rates decreased progressively at a static blood pump speed setting.

The ability of the blood pump tubing segment to return to its manufactured diameter after compression by the roller pump has also been evaluated. Products vary by manufacturer in the degree of compliance, elastic recoil and tubing fatigue characteristics, all of which affect blood pump stroke volumes and, therefore, actual blood flow delivered (Ahmed, Besarab, Lubkowski & Frinak, 2004; Stragier, et al, 1996).

Since the National Kidney Foundation-Dialysis Outcomes Quality Initiative (NKF-DOQI) was published in 1997 (National Kidney Foundation, 2001), Kt/V has been the recognized marker of dialysis adequacy. The level of Kt/V that is the most beneficial to patients may be debated, but it is a commonly used measure. An increase of only 0.1 unit is associated with a 7% decrease in mortality (Ahmed et al., 2004). The outcome of Kt/V can only be improved by increasing the clearance of urea (K) or by increasing the treatment time (t).

Increasing the blood flow rate is one method of increasing small molecule clearance. Studies of dialysis adequacy have found a positive correlation between the blood flow rate and Kt/V as a means of optimizing treatment effectiveness in chronic outpatient settings (Hassell, van der Sande, Kooman, Tordoir & Leunissen, 2001; Ward, 1999). Coyne, Delmez, Spence, and Windus (1997) reported on 375 kinetic modeling sessions during a 3-month period on 146 patients on chronic dialysis. In 42% of patients showing a decline of Kt/V, reduced blood flow rate or shorter treatment time was responsible. Using larger gauge needles to cannulate the arterio-venous vascular access (14 gauge rather than 15 gauge) is another intervention used, when the vascular access allows, to optimize treatment in outpatient clinics. This change also improves blood flow rates and, subsequently, adequacy of treatment as measured by Kt/V (Hoernich, 1998; Mehta, Deabreu, McDougall, & Goldstein, 2002; Sands et al., 1996).

Increasing time (t), or length of the dialysis treatment, is another method of increasing clearances. However, doing so leads to practical, social, and logistical changes that can be problematic for staff and patients alike. For these reasons, the suggestion has been made that it would be appropriate to utilize other methods to improve clearance, such as a larger dialyzer and/or increased blood flow rates, prior to increasing the time of the dialysis session (Zyga, Brokalaki, Virvidakis, & Baltopoulos, 2005).

With the importance of blood flow rate in treatment adequacy so well supported in the literature, the importance of actually achieving the prescribed blood flow rate during treatment cannot be overlooked. However, in the past, there have not been easy or convenient methods available to measure the actual blood flow rate delivered during a patient treatment. Ultrasonic flow methods can be used to measure blood flow. However, there are extra costs involved with this type of testing, including staff time, training, and equipment (Ahmed et al., 2004; Depner et al., 1990; Hassell et al., 2001; Sands et al., 1996; Teruel et al., 2000; Ward, 1999).

The bubble time technique can also be used to measure actual blood flow rate (Ward, 1999). A stopwatch is used to measure the amount of time it takes for a small bubble of air that is injected into the bloodline to move through a specified length of tubing with a known diameter. From this data, the actual blood flow rate is calculated. Errors may occur with this technique due to variations in the size of the bubble injected, accuracy of the starting and stopping of the stopwatch, the position of the bloodline, and changes in the diameter of the bloodline from its expected value. The bubble time technique is generally considered ill suited to the modern dialysis clinic.

Depner et al. (2004) developed a mathematical algorithm as part of the HEMO Study to measure cross-dialyzer urea extraction and true blood flow. However, it is not a simple procedure to implement outside of the experimental environment, making it impractical in most dialysis settings.

In response to concern over the accuracy of blood flow rate measurements, improvements in the technology of modern dialysis machines were made. Some machines can now monitor the actual blood flow rate without the use of additional equipment. The Gambro Phoenix machine measures and displays the blood pump speed as well as the “compensated” blood flow rate. The blood pump speed displayed reflects the blood flow rate value for which the machine was set in ml/min.

The Gambro Phoenix machine also has an online Diascan Kt/V feature. The Diascan monitoring system uses ionized substances to measure clearance, which correlates strongly to urea clearance (Goldau, et al., 2002; Lambie, Taal, Fluck & McIntyre, 2004). During the measurement, the dialysate conductivity at the inlet to the dialyzer is adjusted by 1.0 mS/cm for 2 minutes. The dialysate conductivity is then measured at the hemodialyzer outlet, allowing a mathematical model in the machine to compute several parameters, including ionized Kt/V (Gambro Lundia AB, 2004). Since this ion concentration adjustment occurs within the dialyzer, it yields measurements directly from the patient. The mathematical model in the machine’s computer software, which calculates the Kt/V value, compensates for the effect that access recirculation and the
Calculation of Total Body Water and Percent Volume Distribution

**Percent Volume Distribution Calculation:**

**Male:**
\[
2.447 - (0.09516 \times \text{AGE}) + (0.1074 \times \text{Height in Inches}) + (0.3362 \times \text{Today's weight (kg)}) = \text{TBW}
\]

\[
\left(\frac{\text{TBW}}{\text{Today's wt}}\right) = \frac{\text{Percent Volume Distribution}}{100} = \text{Percent Volume Distribution}
\]

**Female:**
\[
-2.097 + (0.1069 \times \text{Height in Inches}) + (0.2466 \times \text{Today's weight (kg)}) = \text{TBW}
\]

\[
\left(\frac{\text{TBW}}{\text{Today's wt}}\right) = \frac{\text{Percent Volume Distribution}}{100} = \text{Percent Volume Distribution}
\]

**Note:** TBW = Total Body Water.

### Methods

#### Subjects

The study was conducted from October 2005 through January 2006 at the facilities that had begun using the Phoenix machines, which included 5 hospitals in the Denver, Colorado metropolitan area. All patients receiving acute or chronic intermittent hemodialysis treatments at our facilities were eligible for inclusion in the project. Patients were excluded from the project: (a) if their dry weight was unknown or unable to be determined; (b) if the treatment was discontinued earlier than half way through their prescribed treatment time; (c) if any of the key data (forecasts and achieved Kt/V, the length of treatment, and documentation of both the blood pump speed and the blood flow rate) were missing; and/or (d) if the mathematical calculations, described below, were done incorrectly. For the purposes of this study, all treatments performed for patients with acute kidney injury/acute renal failure will be referred to as “acute treatments.” Treatments performed for patients with Stage 5 chronic kidney disease will be referred to as “chronic treatments.”

#### Staff training and education related to the CQI study

Staff members were provided with written goals of the CQI project and instructed on the use of the data collection tool involved. The Diascan on-line Kt/V system requires the staff to enter two values into the Phoenix machine’s computer: the patient’s dry weight and the calculated percent volume of distribution. The data collection form defined the measurements needed and the formulas used in the calculation for both men and women (see Figure 1). Each individual staff member was provided with time to practice using the data collection tool and performing the calculations prior to beginning the project. A written memo was also given to each staff member at his or her individual training session. At a follow-up staff meeting, the details of the process were reviewed. Weekly review of completed data collection forms for accuracy of mathematical calculations and for completeness of the recorded data led to follow-up training of individual staff members when needed.

#### Design and Procedure

The attending nephrologists, according to their clinical judgment, prescribed the blood flow rates. All treatments were done using a Gambro Polystat 140H high flux dialyzer with an 800 ml/min dialysate flow rate. During Phase I of the study all patients received treatments with the blood pump speed set at the prescribed blood flow rate. During Phase II of the study all patients received treatments with the blood pump speed increased until the compensated blood flow rate reached the prescribed blood flow rate. Data were collected until a minimum of 250 treatments with complete data in each group was compiled. This took approximately 7 weeks in both phases.

As part of the pre-treatment assessment, each patient was weighed and measured for height. An estimated dry weight (EDW) was recorded, as well as the method of obtaining that figure, such as outpatient EDW, based on previous hospital treatments, patient’s reported weight before illness, or the nutrition assessment in the patient’s medical record. A data collection form was completed on each patient, including the calculation to determine the patient’s total body water using the Watson formula (Lee et al., 2001). The total body water value was then used to determine the % volume distribution (see Figure 1). The EDW and percent volume distribution values were entered in the Diascan program on the Phoenix machine for its use in calculating the Kt/V.

When the treatment was initiated, the blood pump speed or blood flow rate, depending on the phase, was set.
Statistical Analysis

Data from each treatment and its associated data collection form were entered into an Access database. Patients and their associated treatment data were assigned numbers to protect patient confidentiality during the statistical analysis. Demographic data and summaries of treatment outcomes were tabulated and imported in SAS format for a biostatistician to perform analysis of statistical significance between the two Phases after all personally identifiable information was removed. The following treatment variables were included in the analysis: acute kidney injury vs. chronic renal failure, demographics (both age and gender), admission diagnosis, cause of renal failure, comorbidities, vascular access (type and location), treatment length, liters of blood processed, and total fluid removed.

The Mixed Model was applied to investigate the statistical difference between the blood pump speed and the compensated blood flow rate in each Phase. The Mixed Model (ANOVA with repeated measures) is appropriate for this data set because it includes the modeling of the correlation matrix for observations from the same patient. A Chi-square test verified the need for the Mixed Model, contrasting it with the null model where the covariance matrix is the identity. The Mixed Model was also applied to compare ionized Kt/V between the two methods of setting the prescribed blood flow rate.

Statistical analyses of Phase I and Phase II were done using the SAS computer program. Comparison of forecast Kt/V with achieved Kt/V was done by the Fisher (F) test for analysis of variance. The Mixed Model evaluated relationships between study variables and various treatment variables with a Type III analysis. All tests were two-sided. The level of significance was set at 0.05.

Results

The aggregate data that resulted from this project revealed a statistically significant difference in the mean achieved Kt/V between Phase I, using the blood pump speed as the prescribed blood flow rate, and Phase II, where the blood pump speed was increased so the compensated blood flow rate was set at the prescribed level.

Patient Demographics

Demographic data describing the patient population included in this project are shown in Table 1. The patient population in Phase I was predominantly male (69% male, 31% female) with more chronic treatments than acute treatments (61% chronic, 39% acute). Sixty-eight percent (68%) of treatments used dialysis access catheters (38% temporary catheters, 30% tunneled), 25% fistulas, and 7% A-V grafts.

In Phase II the patient population was more evenly distributed between male and female (59% male, 41% female) with a higher percentage of chronic treatments (82% chronic, 18% acute). Sixty-two percent (62%) of treatments used dialysis access catheters (18% temporary catheters, 38% temporary catheters, 30% tunneled), 25% fistulas, and 7% A-V grafts.

Table 1

<table>
<thead>
<tr>
<th>Demographic Data</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Patients</td>
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<td>96</td>
</tr>
<tr>
<td>Total Treatments</td>
<td>263</td>
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</tr>
<tr>
<td>Male</td>
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<tr>
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<td>Acute Treatments</td>
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<tr>
<td>Male</td>
<td>79</td>
<td>331</td>
</tr>
<tr>
<td>Female</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>Chronic Treatments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>103</td>
<td>123</td>
</tr>
<tr>
<td>Female</td>
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<td>92</td>
</tr>
<tr>
<td>Accesses</td>
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<tr>
<td>Acute catheter</td>
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<tr>
<td>Chronic catheter</td>
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<tr>
<td>Fistula</td>
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</tr>
<tr>
<td>Graft</td>
<td>18</td>
<td>17</td>
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<tr>
<td>Age Ranges</td>
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<td>19-29</td>
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<td>5</td>
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<tr>
<td>30-39</td>
<td>13</td>
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<td>40-49</td>
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<td>60-69</td>
<td>44</td>
<td>58</td>
</tr>
<tr>
<td>70-79</td>
<td>64</td>
<td>70</td>
</tr>
<tr>
<td>80+</td>
<td>41</td>
<td>31</td>
</tr>
</tbody>
</table>
44% tunneled), with 31% fistulas and 7% A-V grafts.

Differences between the values of blood pump speed and compensated blood flow rate. The actual differences between the display values of the blood pump speed and the compensated blood flow rate varied at different pump speed rates. The entire data set had a range of difference between the two values from 8 to 86 ml/min. In Phase I, the range of difference between blood pump speed and compensated blood flow rate was from 20 to 73 ml/min with a mean value of 41.3 (SD ± 9.651) (see Figure 2). In Phase II, the range was from 8 to 86 ml/min with a mean value of 47.3 (SD ± 12.243) (see Figure 3).

Forecast and Achieved Kt/V

The Kt/V results are summarized by phase and the rate of the blood pump speed or blood flow rate in Table 2. More patients had higher Kt/V results when they had higher blood flow rates. The achieved Kt/V was lower than the forecast in both phases of the study. Both the mean forecast Kt/V ($p = 0.0459$) and the mean achieved Kt/V ($p = 0.0311$) were higher in Phase II, when the compensated blood flow rate was set to achieve the prescribed blood flow rate (see Figure 4).

The Mixed Model was applied to compare forecast Kt/V between Phase I and Phase II. The same covariates used for the analysis of achieved Kt/V were included. Only the method of achieving the prescribed blood flow rate and the duration of the treatment showed a significant difference on the forecast Kt/V.

The same approach used for assessing the achieved Kt/V was followed to evaluate for a significant difference between forecast Kt/V and achieved Kt/V. According to the Mixed Model, none of the covariates showed a significant effect on the deviation of the achieved Kt/V from the forecast Kt/V. However, there is a strong indication that setting the prescribed blood flow rate as the compensated blood flow rate results in
both the forecast Kt/V and the achieved Kt/V being higher.

Comparisons by Vascular Access

During Phase I, in treatments done with fistulas for access, the range of difference between blood pump speed and blood flow rate was 30 to 60 ml/min (mean 44, SD ± 7.911), while in Phase II the range was from 8 to 70 ml/min difference (mean 51, SD ± 10.697). During Phase I, in treatments done with grafts for access, the range difference was 30 to 50 ml/min (mean 42, SD ± 7.07), while in Phase II the range was from 30 to 65 ml/min (mean 47, SD ± 8.760). During Phase I, in treatments done with catheters (both temporary and tunneled), the range of difference was 20 to 73 ml/min (mean 38, SD ± 9.849), while in Phase II the range of difference was 10 to 86 ml/min (mean 44, SD ± 12.575). Only the catheter access (see Figure 4)
5) showed a statistically significant difference between phases ($p$ value: 0.0010).

**Acute Treatments vs. Chronic Treatments**

Examination of the data for acute treatments and chronic treatments (see Table 3) in Phase I revealed that 41% of acute treatments resulted in a Kt/V between 1.21 and 1.5, while 22% of chronic treatments fell in that range. In Phase II, 24% of acute treatments resulted in a Kt/V between 1.21 and 1.5, while chronic treatments had 64% in that higher range.

**Discussion**

This project demonstrated the usefulness of dialysis machine technological advances that provide a long sought ability to compensate for the variance between blood pump speed and delivered blood flow rate. The compensated blood flow rate on the Gambro Phoenix dialysis machine is an easy and convenient way to respond to the problem of the blood tubing system delivering less than the prescribed blood flow rate. By quantifying and comparing patients’ Kt/V measurements, we were able to demonstrate a statistically significant difference in the patient’s achieved Kt/V as a result of setting the compensated blood flow rate at the prescribed blood flow rate by increasing the blood pump speed.

Serious attention must be paid to the differences between the blood pump speed and the blood flow rate at given points in time. The difference of 30 ml/min between the blood pump speed and the compensated blood flow rate represents a difference in blood flow through the dialyzer of 30 ml/min. During a 4-hour treatment, this difference results in 7.2 liters of blood not being processed. If you consider the higher range of differences we observed, such as 60 ml/min, then 14.4 liters of blood processed are lost in a 4-hour treatment. Extending consideration to an 80 ml/min difference, 19.2 liters of blood have failed to be processed by choosing to perform the treatment at the blood pump speed instead of the compensated blood flow rate.

The data supported the expecta-

![Figure 5](image-url)

**Table 3**

Kt/V Number and Percentages of Acute Treatments vs. Chronic Treatments

<table>
<thead>
<tr>
<th></th>
<th>Kt/V - # of Treatments</th>
<th>Kt/V - Percentages</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than 1</td>
<td>1-1.2</td>
<td>1.21-1.5</td>
</tr>
<tr>
<td>Phase I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td>21</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>Chronic</td>
<td>9</td>
<td>13</td>
<td>35</td>
</tr>
<tr>
<td>Phase II</td>
<td></td>
<td></td>
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<tr>
<td>Acute</td>
<td>14</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Chronic</td>
<td>20</td>
<td>14</td>
<td>42</td>
</tr>
</tbody>
</table>

**Note:** BPS = blood pump speed; BFR = blood flow rate.
tion that setting a higher blood flow rate and a longer treatment time would produce a higher forecast Kt/V. The data also supported the expectation that both the forecast and the achieved Kt/V would be higher in Phase II.

In this study, the only access showing statistical significance between the phases was the catheter. The difference in Kt/V values for grafts and fistulas in the two phases were not statistically significant. For fistulas, the access of choice in the renal patient population, this is an unexpected finding. There may have been a larger number of “immature” fistulas used as access that required lower blood flow rates. This could have limited the difference between outcomes for fistulas and grafts and decreased the improvement in blood flow rate that would be expected between Phase I and Phase II. There were also a relatively small number of graft accesses in this study, so the data may be different with a more equitable sample. This issue cannot be resolved from the data gathered in this study.

The National Kidney Foundation’s Kidney Dialysis Outcomes Quality Initiative Guidelines (KDOQI) for Hemodialysis Adequacy (National Kidney Foundation, 2006) recommend a Kt/V of 1.2 per dialysis treatment. The guidelines also propose that the target dialysis dose should be at least 15% greater than the recommended minimum dose. A range of 1.2 to 1.4 is, therefore, considered a desirable range of achieved Kt/V for chronic dialysis patients. Since our acute population includes both patients with acute kidney injury and patients with chronic kidney disease, it is interesting to consider whether our patients are receiving an adequate Kt/V while in the acute care setting. The data for our total treatment population revealed 29% of treatments in the 1.21 to 1.5 range in Phase I. This decreased to 21% in Phase II. However, 40% of all treatments exceeded 1.51 in Phase I, increasing to 59% in Phase II. Therefore, in this study, 69% of treatments in Phase I and 80% of treatments in Phase II met or exceeded the minimal KDOQI guidelines for chronic dialysis treatments. These differences were not found to be statistically significant.

Since there are no current standards that specifically address adequacy of hemodialysis in the acute care illness setting, the KDOQI guidelines are the only resource to which one can compare, even indirectly, the results of this study in terms of effectiveness of treatments. It is, therefore, interesting to note that in this study, 66% of Phase I acute treatments exceeded the goal Kt/V for chronic treatment, that value increasing to 86% in Phase II. While 57% of chronic treatments exceed the goal in Phase I, this increased to 84% in Phase II. These differences, while interesting, did not reach statistical significance.

**Limitations**

Ideally, for a project of this type, each patient would serve as his or her own control, receiving treatment with each method and directly comparing the results for each patient. In the acute hospital setting, this is not realistic. Many patients are treated only once or twice and then discharged, which prohibits gathering enough data on each individual for a meaningful comparison. Therefore, we chose to examine a large number of treatments on multiple patients to overcome this limitation. Because of the nature of patient admissions and discharges in the acute setting and the goal of creating a CQI project process that could be clearly understood and functionally consistent for the staff members involved, patients were all treated by using first one method and then the other. This did not allow for randomization.

All of the Phoenix machines used in this project were newly installed. They had been tested and calibrated upon installation. Therefore, the assumption was made that the blood pump speed and the blood flow rates were being measured and displayed correctly. We did not verify the accuracy of the flow rates using independent methods, such as volumetric or ultrasonic flow monitoring, during this project.

Although Kt/V is an accepted standard measure of dialysis adequacy in the chronic outpatient dialysis setting, a standard for patients being treated with intermittent hemodialysis in the acute care setting has yet to be established. This project has demonstrated that using the compensated blood flow rate for the prescription blood flow rate results in higher Kt/V results. Based on the current understanding of urea kinetics, we can assume that those higher results may translate into a benefit for the patient. However, since we do not know what the most beneficial level of Kt/V is for patients with acute kidney injury in the acute setting, we cannot ascertain the degree of patient benefit for that population based on the results of this project.

There are other elements that can impact the accuracy of the Kt/V measurement. Fluid overload is a frequent patient condition in the acute setting. Chronic patients may be fluid overloaded due to an unrecognized change in their EDW in the outpatient setting that led to an admission to an acute care facility. Acute patients may be fluid overloaded due to a sudden onset of anuria or oliguria coupled with failed fluid challenges to stimulate kidney function. Patients requiring either acute or chronic dialysis may be fluid overloaded due to an acute illness process requiring aggressive fluid resuscitation. Therefore, it is often difficult, due to any or all of these scenarios, to determine an accurate dry weight for the patient. Since the dry weight is a component of the calculations used by the Diascan system to measure Kt/V, it is important to establish a standard method of determining the dry weight. This will increase the consistency and, hopefully, the accuracy of the data entered into the Diascan system. We established guidelines for our staff to use to determine the EDW for this project, but it remained a source of concern and difficulty.
among the staff, which could have affected the accuracy of the Kt/V results.

**Recommendations**

Further study utilizing the compensated blood flow rate is needed to replicate the findings of this project. Our results can only be generalized to other populations that are a mix of acute and chronic renal failure patients undergoing intermittent hemodialysis in the acute care setting, not to patients undergoing other forms of acute renal replacement therapy. Independent measurements of the blood pump speed and the actual blood flow delivered to compare with the values displayed by the machine should be conducted.

Based on our experience, studies should follow that continue to explore the use of the compensated blood flow rate to achieve a Kt/V level demonstrating dialysis adequacy in the acute care setting. Comparisons between treatments for acute kidney injury and for chronic renal failure need to be made to differentiate the levels of adequacy currently being provided in each type of treatment before a recommendation for an adequate Kt/V for dialysis treatments in the acute care setting can be developed.

Recent studies suggest that the urea volume of distribution is larger than the total body water estimation from anthropometric measures in patients with acute renal failure who have undergone aggressive fluid resuscitation (Himmelfarb et al., 2002; Ikizler et al., 2004). This possibility will need to be considered as efforts to define an effective Kt/V level for acute kidney injury and the acute care setting continues.

**Summary**

This project was designed to determine if there was a statistically significant difference in Kt/V results when the prescribed blood flow rate was set as the blood pump speed compared to being set as the compensated blood flow rate. The results of this study demonstrated that there is a statistically significant difference, with the compensated blood flow rate producing higher Kt/V results. These results have implications for improving nephrology nurse practice. They have led us to change our acute team practice. We have responded to the evidence and established a policy to set the compensated blood flow rate at the prescribed level for all patients’ hemodialysis treatments. By doing so, we presume that our patients are receiving more effective intermittent hemodialysis treatments while in the acute care setting.

We encourage other practitioners to investigate this hemodialysis machine option and implement its use in their setting. Future studies should proceed to further evaluate the effectiveness of measuring Kt/V in the acute setting as well as gathering data to establish benchmarks for Kt/V in the various patient categories encountered in the acute care setting.

**References**


Complete the Following:

Name: ____________________________________________________________  
Address: __________________________________________________________ 
__________________________________________________________________  
Telephone: ______________________ Email: _____________________________  

CNN: ___ Y es   ___ No  CDN: ___ Y es   ___ No  CCHT: ___ Y es   ___ No  

Payment:  
ANNA Member: ____ Y es   ____ No    Member #___________________________  
□ Check Enclosed  □ American Express  □ Visa  □ MasterCard  
Total Amount Submitted: _________________  
Credit Card Number: _______________________________ Exp. Date: ______  
Name as it Appears on the Card: ______________________________________ 

Special Note  
Your posttest can be processed in 1 week for an additional rush charge of $5.00.  
☐ Yes, I would like this posttest rush processed. I have included an additional fee of $5.00 for rush processing. 

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Note: If you wish to keep the journal intact, you may photocopy the answer sheet or access this posttest at www.annanurse.org/journal 

1. What would be different in your practice if you applied what you have learned from this activity?  
____________________________________________________________________  
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GOAL: To describe a study comparing methods of setting blood flow rate delivered by a dialysis machine. 

New Posttest Format  
Please note that this continuing education activity does not contain multiple-choice questions. We have introduced a new type of posttest that substitutes the multiple-choice questions with an open-ended question. Simply answer the open-ended question(s) directly above the evaluation portion of the Answer/Evaluation Form and return the form, with payment, to the National Office as usual. 

Evaluation  
2. By completing this offering, I was able to meet the stated objectives  
   a. Outline problems encountered in determining blood flow rate delivery by dialysis machines.  
   b. Describe studies done on determining differences in the methods of setting blood flow rate.  
   c. Summarize the results of the study described to determine differences in the methods of setting blood flow rate.  
3. The content was current and relevant.  
4. This was an effective method to learn this content.  
5. Time required to complete reading assignment: _________ minutes.  

Strongly disagree  Strongly agree  
1  2  3  4  5  1  2  3  4  5  1  2  3  4  5  1  2  3  4  5  1  2  3  4  5  1  2  3  4  5  1  2  3  4  5  1  2  3  4  5  1  2  3  4  5

I verify that I have completed this activity ____________________________  
(Signature)