Patterns of Interdialytic Weight Gain During the First Year of Hemodialysis

Janet L. Welch
Susan M. Perkins
Cynthia S. Johnson
Michael A. Kraus

More than 450,000 United States residents are currently diagnosed with end stage renal disease, over 60% of whom are being treated with hemodialysis (United States Renal Data System, 2005). In addition to receiving hemodialysis treatment three times per week, these patients are on restricted diets with fluid limitations. The day-to-day management of fluid intake is particularly troublesome for patients (Welch & Austin, 1999).

Although a “gold standard” does not exist (Kaveh & Kimmel, 2001), fluid intake in the anuric patient is usually limited to approximately 1 liter per day to be considered adherent to the medical recommendation. Not only does the ingestion of fluids increase weight between treatments, but the ingestion of foods with high water content, such as gelatin or soup, also contributes to total fluid intake. Adherence to prescribed fluid limitations is generally poor (Welch, 2001; Welch, Perkins, Evans, & Bajpai, 2003).

This retrospective study describes patterns of interdialytic weight gain (IWG) over the first year of hemodialysis in 27 individuals. IWG increased over the first 12 weeks and appeared to reverse after 12 weeks, increasing again after 32 weeks. Interventions may need to occur after the individual has been receiving treatment for 12 weeks; booster interventions may be indicated after 32 weeks. Variability in the two measures used (mean daily interdialytic weight gain and mean daily percent above dry weight) suggests a need for further study.

Goal
To increase the awareness of patterns of interdialytic weight gain in a study of patients in their first year of dialysis.

Objectives
1. Describe the pattern of weight gain noted in a study of patients in the first year of dialysis.
2. Analyze the suggested need for standardization in interdialytic weight gain measurement.
3. Relate suggested avenues of further research about interdialytic weight gain in patients on dialysis.

Limiting fluid intake to 1 liter per day is important because it reduces the risks of volume overload between dialysis treatments (Abuelo, 1998). Fluid nonadherence contributes to dependent edema and exacerbated hypertension in two-thirds of the hemodialysis population (Amerling et al., 1996; Lindsay et al., 2003). Shortness of breath, often a symptom of pulmonary edema, is associated with visits to local emergency rooms and may result in costly emergent dialysis to remove excess volume (Sacchetti, Harris, Patel, & Attewell, 1991). Fluid nonadherence has also been associated with left ventricular hypertrophy (Parfrey & Foley, 1991), total symptom discomfort (Schneider, Friend, Whitaker, & Wadhwa, 1991), and impaired physical functioning (Christensen et al., 1992).

Additionally, individuals receiving hemodialysis who do not adhere to prescribed fluid restrictions are at risk for premature death (Kimmel et al., 2000; Leggat et al., 1998; Port et al., 2004; Saran et al., 2003).

Some reports indicate that the season of the year may affect adherence to fluid limitations, with higher interdialytic weight gains in the winter season than in summer (Manley & Sweeney, 1986; Tozawa et al., 1999). This seasonal weight gain is associated with concomitant seasonal increases in blood pressure (Argiles et al., 2004). The higher interdialytic weight gains during winter suggest that there may be some influence of the Thanksgiving to Christmas holiday season. For obese persons, the holiday season is also considered a challenging high-risk situa-

Acknowledgments: This research was supported by a grant made available by the Indiana University School of Nursing Research Investment Fund. The authors thank Roberta Delp, Karen Graves, and Qian Li for their help with data collection and Dr. Phyllis Dexter for her valuable critique and editorial assistance.
tion for overeating because there are changes in normal routines that include more time away from home, more socializing and entertaining, and more opportunities to be tempted by food and fluid (Boutelle, Kirschenbaum, Baker, & Mitchell, 1999). Individuals with kidney failure would be confronted with these same challenging situations as they implement their therapeutic dietary recommendations.

The amount of fluid ingested, whether by actual fluid intake or by consuming food composed primarily of water, is indirectly assessed by interdialytic weight gain. Thus, as a patient ingests more fluid, weight increases until the next dialysis session. Most patients have a hemodialysis prescription for fluid removal targeted to dry weight (Jaeger & Mehta, 1999). In the clinical setting, dry weight is routinely reassessed every month to determine whether patients have gained or lost body mass over the previous month (Charra, 1998; Jaeger & Mehta, 1999).

There are two methods for assessing interdialytic weight gain. The first method is mean daily interdialytic weight gain, which has been used in many empirical studies (Brady et al., 1998; Christensen, Benotsch, Wiebe, & Lawton, 1995; Christensen & Smith, 1995; Everett et al., 1995; Leggat et al., 1998; Moran, Christensen, & Lawton, 1998; Schneider et al., 1991; Wirth & Folstein, 1982). The advantages of this computation are that it is simple to perform, the numbers of days between treatments are accounted for, and it allows for normal fluctuations in fluid intake during the interdialytic period. The primary disadvantage of this method is that it assumes that patients get to dry weight at the end of a dialysis treatment, but dry weight is not considered in the calculation. Patients do not always reach dry weight, however.

A less frequently used method to assess interdialytic weight gain is percent above dry weight and this has also been used in some empirical studies (Kimmel, 2000; Kimmel et al., 1996; Wolcott, Maida, Diamond, & Nissenson, 1986). Some consider percent above dry weight a poor measure of interdialytic weight gain because dry weight can only be estimated. Others consider percent of weight above dry weight a better alternative to measuring interdialytic weight gain because individuals with a larger body mass can tolerate larger fluid weight gains than persons with smaller body mass. Another advantage of computing percent above dry weight is that it accounts for variations in dialysis days when all fluid weight is not removed.

Psycho-educational interventions for altering dietary behavior are typically delivered in the clinical setting when individuals initially begin hemodialysis therapy. Thereafter, clinical interventions occur as the need for additional changes in behavior are assessed. There is no empirical evidence, however, that suggests the optimal time to deliver these interventions. In addition, most studies testing interventions to reduce fluid intake do not provide a rationale for the timing of intervention delivery (Welch & Thomas-Hawkins, 2005). Longitudinal data on patterns in interdialytic weight gain are needed to determine the best time for intervention delivery. Moreover, efforts to standardize the calculation of interdialytic weight gain are needed to facilitate the comparisons across studies (Welch & Thomas-Hawkins, 2003) and reflect individual differences that are unrelated to outside factors (Sidani & Braden, 1998). Selecting an outcome measure for interventions may be helped by examining the patterns across time in both mean daily interdialytic weight gain and percent above dry weight.

The purpose of this study is to describe patterns in interdialytic weight gain over the first year of hemodialysis as assessed by two commonly used indicators of interdialytic weight gain to assess the best time for intervention delivery. The specific aims are as follows: (1) describe mean daily interdialytic weight gain and variability in mean daily interdialytic weight gain during the first year of hemodialysis therapy; (2) describe percent above dry weight and variability in percent above dry weight during the first year of hemodialysis; and (3) describe the effects of holidays, season of year, and number of days between treatments on patterns of interdialytic weight gain.

Methods

Design and Sample

A retrospective descriptive design was used. Following institutional review board approval, a list of potential participants was identified using the computer database in existence in the Midwestern dialysis unit that was the setting for the study. Those patients who had initiated hemodialysis therapy between September 2000 and October 2002 from one hemodialysis unit in a large, urban outpatient facility were eligible to participate. The patients who continued hemodialysis at the time of data collection were approached by the nephrology research nurse during hemodialysis treatment to explain the study and invite participation. After receiving informed consent, pre- and post-dialysis weights were retrieved from the computer database. For patients who initiated hemodialysis during September 2000, pre- and postdialysis weights from September 2000 through August 2001 were obtained. For patients who initiated hemodialysis during October 2002, pre-and postdialysis weights were collected from October 2002 through September 2003. Data retrieval began in 2003 and continued through early 2004. In addition, age, gender, race, estimated dry weight, and changes in estimated dry weight during the first year of hemodialysis were retrieved from the medical record.

The initial potential sample included 31 patients who were identified as beginning hemodialysis in September 2000 and October 2002. We were able to obtain pre- and postdialysis weights on only 27 of these individuals. Two patients refused to participate, one was unable to give informed consent, and one was a prisoner and not eligible. Our final sample consisted of 27 individuals. The mean age of these participants was 58.5 years (SD = 15.7; range
Small majorities of the sample were male (55.6%) and white (54.2%).

**Measurement**

Interdialytic weight gain was assessed in two different ways: mean daily interdialytic weight gain and percentage above dry weight. Both measures require the use of clinical weights obtained during treatment. Scales are set to zero prior to each individual weight and calibrated monthly to ensure accuracy. Patients have a regularly scheduled day and time of treatment so weights are obtained at approximately the same time for each dialysis session. Typically, patients are weighed on the same scale at each treatment.

**Mean daily interdialytic weight gain.** A mean daily interdialytic weight gain value was computed for each of the 156 hemodialysis sessions patients received over the first year of treatment. Mean daily interdialytic weight gain was computed by subtracting the postdialysis weight from the previous treatment from the predialysis weight of the current treatment. This value was divided by the number of days between treatments.

**Mean daily percent above dry weight.** Percentage above dry weight was computed for each of the 156 hemodialysis sessions patients received over the first year of treatment. Mean daily percent above dry weight was computed by subtracting the postdialysis weight from the previous treatment from the predialysis weight of the current treatment. This value was divided by the estimated dry weight and then divided by the number of days between treatments. Finally, the resulting number was multiplied by 100. The value for dry weight was updated as changes in dry weight were made.

**Data Analysis**

A mixed model of the mean daily interdialytic weight gain repeated within each subject was fit to obtain estimates of the between- and within-subject variability for this outcome. After performing a sensitivity analysis to explore different correlations structures for the repeated measures, a covariance structure specifying that the correlation between all pairs of repeated measures was identical (i.e., compound symmetry) was chosen. Next, both linear and quadratic week terms were added to the model to examine the change of mean daily interdialytic weight gain over time. After assessing the change over time, additional models were fit that included a term for holiday (yes if the date was between Thanksgiving and New Year’s Day, no otherwise), season (spring, summer, fall, winter), and days between dialysis treatments (2 vs. 3 days) along with the linear and quadratic effects of week. This analysis was repeated using mean daily percent above dry weight as the outcome variable.

**Results**

Descriptive statistics are presented by holiday (see Table 1), season (see Table 2), and interval between treatments (see Table 3) for both mean daily interdialytic weight gain and mean daily percent above dry weight. In general, the mean daily interdialytic weight gain was approximately 1 kg and the mean daily percent above dry weight was 1.3%.

<table>
<thead>
<tr>
<th>Holiday</th>
<th>Number of Patients</th>
<th>Mean (kg)</th>
<th>SD</th>
<th>Number of Patients</th>
<th>Mean (%)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>25</td>
<td>1.01</td>
<td>0.39</td>
<td>25</td>
<td>1.32</td>
<td>0.43</td>
</tr>
<tr>
<td>No</td>
<td>27</td>
<td>0.96</td>
<td>0.33</td>
<td>27</td>
<td>1.27</td>
<td>0.32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Season</th>
<th>Number of Patients</th>
<th>Mean (kg)</th>
<th>SD</th>
<th>Number of Patients</th>
<th>Mean (%)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>25</td>
<td>0.98</td>
<td>0.40</td>
<td>25</td>
<td>1.27</td>
<td>0.43</td>
</tr>
<tr>
<td>Winter</td>
<td>25</td>
<td>1.02</td>
<td>0.40</td>
<td>25</td>
<td>1.32</td>
<td>0.41</td>
</tr>
<tr>
<td>Spring</td>
<td>25</td>
<td>0.97</td>
<td>0.30</td>
<td>25</td>
<td>1.29</td>
<td>0.31</td>
</tr>
<tr>
<td>Summer</td>
<td>27</td>
<td>0.98</td>
<td>0.39</td>
<td>27</td>
<td>1.30</td>
<td>0.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interval</th>
<th>Number of Patients</th>
<th>Mean (kg)</th>
<th>SD</th>
<th>Number of Patients</th>
<th>Mean (%)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Days</td>
<td>27</td>
<td>1.03</td>
<td>0.36</td>
<td>27</td>
<td>1.35</td>
<td>0.37</td>
</tr>
<tr>
<td>3 Days</td>
<td>27</td>
<td>1.00</td>
<td>0.34</td>
<td>27</td>
<td>1.32</td>
<td>0.34</td>
</tr>
</tbody>
</table>
Plots of mean daily interdialytic weight gain and mean daily percent above dry weight over the 52 weeks are presented in Figures 1 and 2. For ease of plotting, each patient’s mean daily interdialytic weight gain and mean daily percent above dry weight were calculated for each week and the average ± standard error of the weekly averages for the 27 patients was plotted.

Using mean interdialytic weight gain, the between-subject variability was estimated to be 0.11, and the within-subject variability estimate was estimated to be 0.34 in the mixed model. These variances were significantly different from zero (\( p = 0.0009 \) and \( p<0.0001 \), respectively). There was both a significant linear (\( \beta = 0.011, p<0.0001 \)) and quadratic (\( \beta = -0.00015, p = 0.0038 \)) effect for week. As shown in Figure 1, the increase in mean daily interdialytic weight gain was greatest during the early weeks and leveled off in the later weeks. There were no significant effects for holiday, season, or days between treatments on mean daily interdialytic weight gain.

In the mixed model using mean percent above dry weight as the outcome, the between-subject variability was estimated to be 0.098, and the within-subject variability estimate was 0.64. These variances were also significantly different from zero (\( p = 0.0005 \) and \( p<0.0001 \), respectively). There was both a significant linear (\( \beta = 0.014, p = 0.0002 \)) and quadratic (\( \beta = -0.002, p = 0.005 \)) effect for week. As with mean daily interdialytic weight gain, the increase in mean percent above dry weight was greatest during the early weeks and leveled off in the later weeks. There were no significant effects for holiday, season, or days between treatments.

Post-hoc analyses were done limiting the analysis to interdialytic weight gain measures collected after 12 weeks on dialysis. In these models, both linear terms were negative (mean interdialytic weight gain: \( \beta = -0.017, p = 0.0085 \); mean percent above dry weight: \( \beta = -0.026, p = 0.0032 \)) and both quadratic terms were positive (mean interdialytic weight gain: \( \beta = 0.00028, p = 0.0051 \); mean percent above dry weight: \( \beta = 0.00041, p = 0.0030 \)). These findings, as shown in Figures 1 and 2, suggest an initial decrease in interdialytic weight gain from 12 to 32 weeks, followed by slight increase.

**Discussion**

Most previous research has focused on variables associated with fluid adherence as measured by interdialytic weight gain. This study, however, examined patterns of interdialytic weight gain over the first year of hemodialysis treatment in an effort to assess the best time for delivering interventions to reduce fluid intake and to determine an appropriate outcome measure. It should be noted, however,
that mean interdialytic weight gains in this sample were generally within clinical recommendations, however, a number were above the recommendations and in need of intervention.

In this sample, both mean daily interdialytic weight gain and mean daily percent above dry weight gradually increased over the first 12 weeks of therapy and the pattern appeared to reverse after 12 weeks. Dialysis therapy usually begins when 90% to 95% of renal function is lost. It was not surprising, therefore, that mean daily interdialytic weight gain increased during the first 12 weeks of treatment. Our findings probably reflect the existence of residual urine output in our sample. Residual urine output may have diminished or stopped altogether after 12 weeks. We did not, however, collect these data.

The fact that there were slight decreases in interdialytic weight gain after the first 12 weeks of therapy suggests that interventions may be more relevant to patients and most likely to be effective after an individual has been on dialysis for at least 3 months. If interventions are delivered earlier, individuals receiving hemodialysis may not perceive that the intervention is personally relevant and the likelihood of success may decrease (Rollnick, Mason, & Butler, 2000). Delaying these important health messages may also help alleviate the volume of information patients receive at the initiation of dialysis therapy. It also appears that interdialytic weight gain begins to increase again after receiving hemodialysis for 32 weeks suggesting that self-managing fluid intake becomes more difficult over time. Booster interventions may be needed at this point in time if these patterns are replicated in future studies.

In contrast to other reported findings (Argiles et al., 2004; Manley & Sweeney, 1986; Tozawa et al., 1999), we did not find seasonal or holiday effects. In addition, we did not find that the number of days between treatments affected interdialytic weight gain. Although these results suggest that booster interventions would not be needed during the different seasons in the Midwest or during the Thanksgiving or during the Thanks-giving to Christmas holidays, these findings may be limited by the small sample size and deserve further study.

Comparing the two outcomes for measuring interdialytic weight gain, it can be seen from Figures 1 and 2 that both measures are capturing the general trend over time in a similar manner. Within-subject variability in mean daily interdialytic weight gain, however, was approximately one-half the within-subject variability in mean daily percent above dry weight; between-subject variability was similar for the two outcomes. When within-group variability is lower, reliability or precision improves (DeKeyser & Pugh, 1997). Moreover, analyses using a dependent measure with smaller within-group variability will increase statistical power, which improves the detection of between-group differences (Lapsley, 1990). The relative variability of the two measures suggests that additional information is needed about the dependent measure.

Although patterns in interdialytic weight gain were identified in this sample, additional research should be conducted on the dependent measure. In past research, the interdialytic periods used in mean calculations of interdialytic weight gain varied considerably within and between studies (Welch & Thomas-Hawkins, 2005). For example, mean weight gain was calculated in one study at one measurement period using all recorded weight gains for 12 weeks following completion of an intervention and yet calculated baseline weight gain using weight gain over the 3 dialysis sessions before and the 3 sessions after the baseline interview (Cummings, Becker, Kirsch, & Levin, 1981) and in another study mean weight gain was calculated based on 4 measures at 1 month, 8 measures at 3 months, and 12 measures at 6 months (Tsay, 2003). The inconsistent approaches to calculating interdialytic weight gain are problematic because different approaches may have more variability, which could, in turn, decrease statistical power. Standardization in interdialytic weight gain measurement is needed and would facilitate comparisons of intervention effects across studies. A measurement study to determine effect sizes using different measures of interdialytic weight gain would also contribute to nephrology science.

Potential limitations of this study include the small sample size, convenience sample, and the retrospective design. A change in computer software after the collection of data for the 27 subjects in this study resulted in a loss of retrospective data that would have allowed us to increase our sample size. Because this was a retrospective study and it was required that subjects still be receiving dialysis at the time of data collection, it is likely that patients with more severe conditions may have been excluded, which could limit generalizability.

Conclusions

There is preliminary support for delivering interventions to reduce fluid intake after an individual has been receiving hemodialysis therapy for 12 weeks. Booster interventions may also be needed after individuals have been receiving hemodialysis for 32 weeks. Although mean daily interdialytic weight gain appeared to be a better measure in this small sample, further testing with larger samples is needed to confirm the findings.

References


**ANNJ619 ANSWER/EVALUATION FORM**

**Patterns of Interdialytic Weight Gain During the First Year of Hemodialysis**
Janet L. Welch, DNS, RN, Susan M. Perkins, PhD, Cynthia S. Johnson, MA, & Michael A. Kraus, MD

**Posttest Instructions**
- Answer the open-ended question(s) below.
- Complete the evaluation.
- Send only the answer form to the ANNA National Office; East Holly Avenue Box 56; Pitman, NJ 08071-0056; or fax this form to (856) 589-7463.
- Enclose a check or money order payable to ANNA. Fees listed in payment section.
- Posttests must be postmarked by October 20, 2008. Upon completion of the answer/evaluation form, a certificate for 1.3 contact hours will be awarded and sent to you.
- Please allow 2-3 weeks for processing. You may submit multiple answer forms in one mailing, however, because of various processing procedures for each answer form, you may not receive all of your certificates returned in one mailing.

**Complete the Following:**

Name: __________________________________________________________
Address: _________________________________________________________
Telephone: ____________________ Email: _____________________________

**Evaluation**

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

2. By completing this offering, I was able to meet the stated objectives
   a. Describe the pattern of weight gain noted in a study of patients in the first year of dialysis.
   b. Analyze the suggested need for standardization in interdialytic weight gain measurement.
   c. Relate suggested avenues of further research about interdialytic weight gain in patients on dialysis.
   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.

I verify that I have completed this activity ____________________________

(Signature)

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

Submit Online!

Online submissions through a partnership with HDCN.com are accepted on this posttest at $20 for ANNA members and $30 for nonmembers. CE certificates will be available immediately upon successful completion of the posttest.

GOAL

To increase the awareness of patterns of interdialytic weight gain in a study of patients in their first year of dialysis.

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.