Reducing Hydration-Linked Events in Nursing Home Residents

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The authors used a quasi-experimental treatment and control group design with 49 participants from four nursing homes to test the effectiveness of an 8-week hydration intervention in reducing hydration-linked events (HLEs). A Kaplan Meier survival curve with log rank test was calculated to determine incidence and time to occurrence of a HLE. Incidence of and time to a HLE did not differ between the treatment and control groups over an 8-week period (p > .05). However, treatment group participants were found to be more frail, more cognitively impaired, and more at risk for acute confusion than the control group participants. Although there were no statistically significant differences between the groups, it is clinically significant that the frailer, more at-risk participants in the treatment group had a lower incidence of HLEs.

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Nursing homes (NHs) are under increasing scrutiny to provide quality care to their often complex, frail residents. Adequate

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oral hydration is essential to optimal physiological function, such as good renal function, vascular perfusion, and immune function (Mentes, Culp, Maas, & Rantz, 1999), but is often hard to maintain because of institutional and resident issues. We report on a study that evaluated the use of a hydration management intervention to reduce hydration-linked events (HLEs) in nursing home residents.

**CONSEQUENCES OF DEHYDRATION**

Maintaining adequate oral hydration for elderly residents of NHs is an ongoing challenge for NH staff members (Armstrong-Esther, Browne, Armstrong-Esther, & Sander, 1996; Kayser-Jones, Schell, Porter, Barbaccia, & Shaw, 1999; Mentes et al., 1999). The prevalence of underhydration or dehydration in NH residents is estimated at 33% (Colling, Owen, & McCreedy, 1994; Mentes et al., 1999). The term dehydration is used to signify different fluid and/or electrolyte problems, usually based on the concentration of sodium (Lavizzo-Mourey, 1987; Silver, 1990), and fluid volume depletion. Therefore, although all types of dehydration are encountered in NHs, the most prevalent type can be described as a subclinical state of dehydration or chronic underhydration, where an elder does not adequately replenish fluids (Colling et al., 1994; Weinberg & Minaker, 1995). This is further supported by the work of Gaspar (1988, 1999), Kayser-Jones et al. (1999), and Chidester and Spangler (1997), who examined fluid intake in NH residents and reported that between 50% and 92% of residents had inadequate fluid intake based on a nutritional standard.

Risk factors for dehydration in the NH population are difficult to determine. Although Lavizzo-Mourey, Johnson, and Stolley (1988) identified female gender, age more than 85 years, more than four chronic illnesses, more than four medications, and requiring assistance with transfer and ambulation as risk factors for dehydration, their findings have not been replicated in more recent studies (Gaspar, 1999; Mentes, 2001). The relationship between functional status and risk for dehydration has been intriguing. Earlier studies (Gaspar, 1988; Lavizzo-Mourey et al., 1988) reported that residents who required some assistance or were semidependent in activities of daily living were at higher risk for dehydration, presumably because they
needed reminders or sporadic help with drinking. However, more recent studies (Gaspar, 1999; Mentes, 2001) found that the more physically functional resident was at increased risk for dehydration. Gaspar’s (1999) study examined water intake from food and fluids in 99 residents living in three nursing homes. The results showed that inadequate water intake was associated with older age, higher levels of functional status, intact speech, semidependent with eating, few ingestion sessions, and inadequate nutrient intake.

The consequences of a chronically underhydrated state are acute confusion, dehydration, urinary and respiratory infections, falls, and constipation, all of which could precipitate a preventable hospitalization (Palevsky, Bhagrath, & Greenberg, 1996) and place elderly individuals at increased risk for repeated hospitalizations (Gordon, An, Hayward, & Williams, 1998). The insidious state of chronic underhydration becomes a physiologic balancing act in which the frail elder becomes increasingly susceptible to small environmental or physiologic stressors that can precipitate dehydration and subsequent acute health problems. Ramifications of chronic underhydration are further obscured by the fact that once an elderly individual is hospitalized and treated for an acute health crisis, such as pneumonia, the antecedent condition of underhydration or dehydration is often overlooked (Mentes & Iowa–Veterans Affairs Nursing Research Consortium [IVANRC], 2000). Therefore, although the cost of hospitalizations for dehydration in 1996 exceeded $1 billion (Kayser-Jones et al., 1999), it is likely that the true figure is much higher.

**PURPOSE**

The purpose of this investigation was to test whether the use of a hydration management intervention designed to meet NH residents’ hydration needs would prevent or minimize episodes of acute confusion and urinary tract and respiratory infections in this population. These events were considered hydration-linked if the infection or episode of acute confusion was preceded by a urine specific gravity (SG) of ≥ 1.020 and decreased fluid intake as measured by intake records. The research hypothesis for this investigation was:
Residents who receive care based on a hydration management intervention will have a lower incidence of HLEs than residents who receive standard nursing care.

DESIGN

We employed a quasi-experimental, treatment-control group design to test the effectiveness of an 8-week hydration management intervention with elderly NH residents. Treatment or control group status was randomly assigned to each of the participating facilities by a coin toss prior to participant recruitment. Individual randomization was not possible given the nature and visibility of the hydration intervention.

PARTICIPANTS AND SITES

Participants were recruited from elderly (65 or older) residents of four long-term care facilities in eastern Iowa. Participants who had a diagnosis of dementia were included if they could adequately participate in baseline and outcome measurement activities. Individuals were excluded if they had unstable congestive heart failure or diabetes, renal disease (creatinine > 3.5 mg/dL), hyponatremia (serum sodium < 135 meq/L), were terminally ill, acutely confused, or had a urinary tract infection at baseline. The sample included a total of 49 participants, 25 in the treatment group and 24 in the control group. All participants were Caucasian except for 1 who was African American. Table 1 presents demographic and clinical characteristics of the groups. At baseline there were no significant differences between the treatment and control groups on gender, age, number of medical diagnoses, or number of medications prescribed. However, treatment participants’ length of stay ($M = 23$ months) in their facility was significantly shorter than that of control participants ($M = 95$ months, $p < .000$).

The research sites included four NH facilities; specifically, two Veterans Affairs (VA) facilities in Iowa and two comparable community nursing homes. Each site voluntarily agreed to participate in this study by completing a letter of support. Stratified sampling by gender ensured gender balance for this study through the use of VA facilities that predominantly serve male veterans and community nursing home facilities where
the population is predominantly female. The facility staff in both the treatment and control group sites assisted in reporting acute changes in cognitive and behavioral status, however, the research staff scored the Mini Mental State Exam (MMSE) and NEECHAM Confusion Scale (NEECHAM) on all occasions. The facility staff in the treatment facilities also assisted in the delivery of the intervention.

**METHOD**

**Hydration Management Intervention**

The hydration management guideline that serves as the basis for this intervention has been presented elsewhere (Mentes & IVANRC, 2001). Briefly, the hydration management intervention for this study was based on calculating a daily individual fluid goal for each participant adjusted for his or her weight. This standard allows for 100 mL/kg for the first 10 kilograms of weight, 50 ml/kg for the next 10 kilograms, and 15 ml/kg for the remaining kilograms of weight and has preli-
nary validity as a standard for daily fluid intake in this population (Chidester & Spangler, 1997). Methods for ensuring that a participant met his or her goal were developed from an extensive baseline assessment. Strategies for providing adequate fluids included any of the following: standardized 6 ounces (180 ml) fluid intake with each medication administration, fluid rounds morning and evening, and “happy hours” or “tea time” twice a week in the late afternoon. An evaluation component is included in this intervention. Weekly urinalyses coinciding with a 24-hour fluid record were conducted to determine whether and to what extent a participant achieved adequate hydration.

Measures

Baseline clinical information. Data collected at baseline included cognitive functioning as measured by the MMSE (Folstein, Folstein, & McHugh, 1975), affective function as measured by the Geriatric Depression Scale-15 Short Form (McGivney, Mulvihill, & Taylor, 1994), and functional status as measured by the FIM instrument. Baseline assessment of acute confusion was accomplished using the NEECHAM. Medical diagnoses and current scheduled and PRN (as needed) medications were also recorded.

Dehydration risk appraisal. Assessment for dehydration risk was completed using a checklist of items (e.g., health conditions, medications, intake behaviors, and functional, cognitive, and affective status) developed by the first author from the research literature (Mentes & IVANRC, 2000). Information for the checklist was derived from the baseline assessment. A higher number of items checked implied increased risk.

Acute confusion assessment. An assessment algorithm that consisted of the MMSE (Folstein et al., 1975) and NEECHAM (Neelon, Champagne, Carlson, & Funk, 1996) was used at baseline and at the time of a suspected episode of acute confusion for both the treatment and control group. The assessment process was triggered if a participant exhibited a sudden change in mental status as observed by the research staff or when the NH reported a cognitive or behavioral change in
resident behavior. A participant was considered acutely confused if he or she scored lower than baseline on the MMSE and lower than 25 on the NEECHAM. Reliability and validity are well established for the MMSE (Crum, Anthony, Bassett, & Folstein, 1993). The NEECHAM was selected because it was easily implemented in the long-term care setting (Rapp et al., 2000).

**Infection documentation.** Infections diagnosed by the primary care provider including urinary tract and upper respiratory infections, pneumonia, and influenza, were documented. The date and treatments ordered for the infection were also noted.

**Urine color and SG.** Using a urine color chart developed by Armstrong and colleagues (1994, 1998), urine color was assessed weekly. The chart has been previously evaluated in elderly patients by the authors and published elsewhere (Wakefield, Mentes, Diggelmann, & Culp, 2002). The urine color chart is a low-cost, practical tool for monitoring hydration status in small NH facilities. Immediately after collection, the specimen was placed in a clear test tube held against the color chart with a white background. The number of the color (1-8) was used to code the color (higher numbers indicate darker urine color). Any medications affecting urine color were noted at the start of the study. Urine SG was determined by using the Chemstrip Mini UA Urine Analyzer (Boehringer Mannheim Corporation) along with Chemstrip 10M UA urine test strips.

**Research Staff**

Two research assistants, one registered nurse (RN) and one nurse aide (NA) or student nurse, worked at each research site. All RN research assistants who were responsible for coordinating the research implementation at their site were given intensive training on recruitment of participants, data collection, and intervention/usual care implementation. RNs at the VA sites had participated in an Acute Confusion Resource Nurse program sponsored by the IVANRC, which is described elsewhere (Rapp et al., 1998). RN research assistants at the community sites received a comparable training session. The project director made weekly visits to the research sites to monitor
research progress and ensure that the research protocol was being implemented.

RN research assistants in both groups were responsible for collecting the baseline data and weekly urinalysis, fluid records, and infection and treatment information. They coordinated and documented the daily acute confusion ratings in conjunction with the nursing staff. The RN research assistant in the treatment group was informed of the fluid goal for each participant in her group and actively planned to meet the goal based on strategies from the hydration management intervention, whereas the control group RN research assistant was blinded to the control group participants’ fluid goals and was to promote usual-care practices. The NA research assistants in both groups were to assist the RN research assistant, specifically with urine specimen and fluid record collection. The treatment group NA research assistants had the additional duty of providing fluids for the participants through fluid rounds or special groups, such as tea time.

DATA ANALYSIS

All data were analyzed using the Statistical Package for the Social Sciences Version 8.0. Descriptive statistics were used to analyze the demographic data. Nonparametric statistics were used to compare hydration data trends between the treatment and control groups over the course of the study. Survival analysis was used to calculate the incidence of HLEs in both groups.

FINDINGS

There were no significant differences between the groups in cognitive status or depression at baseline; however, there was a significant difference ($p = .003$) between groups on confusion status (NEECHAM), where the treatment group ($M = 26.4$) was more at risk for acute confusion than the control group ($M = 28.4$). In addition, the treatment group had more participants with a diagnosis of dementia than the treatment group (9 vs. 2, $p = .02$). Furthermore, mean scores on the FIM revealed that treatment group participants were physically more frail than control group participants ($p = .000$; see Table 1).
Efficacy of Hydration Intervention

Mann Whitney U statistics were used to evaluate differences in urine color, SG, and percentage of fluid goal met between treatment and control group participants at baseline and averaged over the 8-week observation period (see Table 2). Treatment group participants’ SG was lower at baseline ($p = .002$) and remained lower than that of control participants throughout the intervention ($p = .07$). Likewise, color ratings were lower in the treatment group throughout the study time. Although control group participants, on average, exceeded their fluid goal and had fewer persons not meeting their fluid goals at baseline (11 vs. 13), treatment participants’ mean compliance with fluid goals over the study period exceeded that of control participants (95% vs. 89%, $p = .08$). Furthermore, 12 treatment group participants (vs. 13 at baseline) were not meeting their fluid goal at the completion of the study, and only 3 persons (vs. 6 at baseline) were meeting less than 75% of their goal. Control group participants had more individuals not meeting their fluid goal at the end of the study as compared to baseline (13 vs. 11) and had more persons meeting less than 75% of their goal at the end of the study (4 vs. 2).

Table 2

Comparisons of Specific Gravity, Urine Color, and Percentage Fluid Goal Between Treatment and Control Groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement Time</th>
<th>Treatment Group (n = 25)</th>
<th>Control Group (n = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>Baseline***</td>
<td>1.0166</td>
<td>0.0052</td>
</tr>
<tr>
<td></td>
<td>Average &gt; 8 weeks**</td>
<td>1.0163</td>
<td>0.0030</td>
</tr>
<tr>
<td>Urine color</td>
<td>Baseline</td>
<td>2.2</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Average &gt; 8 weeks</td>
<td>2.2</td>
<td>0.99</td>
</tr>
<tr>
<td>% fluid goal</td>
<td>Baseline</td>
<td>99</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Average &gt; 8 weeks*</td>
<td>95</td>
<td>17</td>
</tr>
</tbody>
</table>

*p = .08, **p = .07, ***p = .002, Mann Whitney U.
A HLE is defined as any episode of acute confusion or of urinary or respiratory tract infection that was preceded by a urine SG of ≥ 1.020 and decreased fluid intake as measured by intake records. A specific gravity of ≥ 1.020 was selected for several reasons. First, older individuals have decreased ability to concentrate their urine as a function of age-related changes. Second, the average SG of both groups at baseline was lower than 1.020, ranging between 1.0176 and 1.0178, and there is evidence that a SG of 1.020 signifies a state of mild dehydration (Kavouras, 2002). Types of HLEs included acute confusion episodes, urinary tract infections, upper respiratory infection, pneumonia, and influenza (see Table 3). The incidence of HLE in the treatment group was three events per 63 days of follow-up and for the control group was six events per 60 days of follow-up (relative risk ratio = 0.48, 95% confidence interval 0.18-1.26). Kaplan-Meier survival estimates with a log rank test were used to compare differences in the survival curves. These results demonstrate no significant differences in the time to occurrence of a HLE between the treatment and control groups. (log rank test = 0.74, p = 0.39).

**DISCUSSION**

Maintaining adequate hydration in nursing home residents is a difficult task that requires consistent nursing staff com-
munication and persistence on the part of the direct care staff. When other care duties interfere, hydration activities are neglected, putting NH residents at increased risk for dehydration, infections, constipation, and acute confusion. In this study, we attempted to show that a hydration management intervention could reduce episodes of infection and acute confusion preceded by a state of underhydration as measured by urine SG and intake records. Although statistically significant differences were not demonstrated in the incidence rates of HLE between treatment and control groups because of the small sample size, this study nevertheless has clinically significant implications for nurses caring for elders in NHs. This clinical significance is supported by the fact that despite being physically more frail (FIM = 79.4 vs. 112.2, \( p < .001 \)), more cognitively impaired (MMSE = 22 vs. 24.6, \( p = .06 \)), and more at risk for acute confusion (NEECHAM = 26.4 vs. 28.3, \( p = .003 \)), the treatment group participants had 50% fewer HLEs than members of the control group.

A review of the limitations of the investigation further highlights the clinical significance of this work. Limitations include issues with randomization, sample size, and the hydration intervention delivery.

**Randomization Issues**

Randomization of individuals into treatment or control groups was not feasible for this study given the nature and visibility of the intervention; as such we randomized at the facility level. The lack of individual randomization created a selection bias that produced groups that differed in significant ways, specifically in functional abilities, risk for acute confusion, and length of stay at their NH. This emphasizes a difficulty with testing direct care interventions that are not easily blinded for participants and investigators, thus not permitting individual randomization to treatment and control groups.

**Sample Size**

Inadequate sample size provided insufficient power to detect meaningful differences between groups. The restricted sample size was in part due to one research site’s limitations on recruitment for fear of staff burden with an intervention study.
This was problematic because the facility where recruitment was capped was larger and had participants at varying levels of functional and cognitive abilities.

Recruitment posed an additional problem for establishing an adequate sample size. Although attrition is often seen as a major problem with maintaining an adequate sample size of older adults, refusal to participate appeared to be a bigger problem in this study, especially in the control group where the refusal rate was 55% of eligible participants versus 20.5% in the treatment group. This was higher than the range of refusal rates reported from other NH studies of 30% to 50% (Eisch, Colling, Ouslander, Hadley, & Campbell, 1991; McNeely & Clements, 1994; Ouslander & Schnelle, 1993). Perhaps this was due to the fact that potential participants saw only the burden and no personal benefit to participation as a control participant. In several cases, potential control and treatment participants refused participation because of the language in the consent form, some of which was beyond the control of the investigator due to institutional review board requirements. As one of the research assistants described it, “They felt like they were signing their life away. The form should be better designed for older residents.”

**Hydration Intervention Delivery**

Although the treatment group had a lower incidence of hydration-linked infection and acute confusion than the control group, only small differences between the groups based on intake recordings and urine color and SG were apparent. This could be attributed to several causes: insufficient application time to produce a more dramatic effect, an initial control group bias toward altering hydration practices due to the scrutiny of the study, or a lack of a risk-specific program. The time to benefit from a hydration program is not known; however, there is compelling physiological evidence that older individuals’ homeostatic mechanisms are slowed and, therefore, they are less adaptable to quick shifts in physiologic status, such as a significant changes in fluid intake (Miescher & Fortney, 1989; Phillips, Johnston, & Gray, 1993). Therefore, the consistent intake of adequate fluids would be the goal. The trend toward increasing daily intake persisted in the treatment group over the course of the study, whereas the control group dropped off
by the end of the study. This may indicate that the observation
time in this study was too short to detect the true benefit of a
consistently applied hydration management program. Addi-
tional studies should consider using a longer intervention
period to establish and maintain adequate hydration while
measuring the incidence of HLEs in this population.

The lack of apparent differences between the groups might
also be due to control group staff altering their standard
hydration practices as a result of being aware of research staff
collecting data on participants’ intake. It would be expected
that this bias (increased offering of fluids) might decline over
time as the staff becomes accustomed to the research assis-
tant’s presence. This might also explain why the control
group’s average intake declined over the course of the study.
Furthermore, control group participants, because of their
increased functional and cognitive ability, may have had more
resilience in the face of fluctuating daily intake levels. For
example, one participant in the control group exhibited urine
SG levels of 1.030 and reduced fluid intake over a 3-week
period prior to developing an episode of acute confusion.

Finally, the hydration intervention might have proven more
efficacious if hydration strategies were tailored to a partici-
 pant’s specific risk factors. In this study, about 50% of partici-
 pants in both groups were meeting their fluid goal at baseline
and continued to have adequate intake throughout the study
period. In addition, we found that 75% of our participants
drank at least some, and often all, of the fluids that were offered
to them by the research staff. This suggests that the efforts of
nursing staff members would best be directed at using strate-
gies for hydration management that are practical given the res-
ident’s level of risk for dehydration.

APPLICATION

Future directions for providing adequate hydration for NH
residents should include consideration of level of risk for dehy-
dration and the contextual reasons for the risk. Individual resi-
dents should be thoroughly screened for hydration problems
on admission to the NH. From this assessment, hydration
management strategies should be tailored for the individual
who is at risk and the time constraints of the nursing staff. For
example, more functional residents can be taught strategies to manage their own hydration needs and to report to the staff when they feel too ill to eat or drink adequately. Residents with dementia, who are physically able to get fluids by themselves but often forget, need to be monitored closely, and physically frail residents require frequent offers of fluids throughout the day. Residents with special needs, such as dysphagia or fear of incontinence, should also be considered.

The use of a monitoring system, other than the traditional intake and output recordings, is another important contribution from this study. Urine color has been highly correlated with urine SG and can be an easy method for detecting impending hydration problems if a baseline color is established for the resident and the chart is used consistently (Wakefield et al., 2002).

Dehydration continues to be a complex health problem for elders in NHs, with dire health consequences if adequate hydration is not maintained. Therefore, nurses, certified nursing assistants, activity personnel, and family members must work together to prevent dehydration in NH elders. This investigation highlights the difficulties with exploring dehydration and suggests strategies for further study of this significant health problem.

REFERENCES


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