

Risk Factors and Outcomes Associated with Hospital Admission for Dehydration

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KEY WORDS

dehydration
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The hospital admission rate for dehydration is one of the Agency for Healthcare Research and Quality Prevention's Quality Indicators, which are considered screening tools for potential quality issues. Thus, admission for dehydration may reflect the quality of care provided in community settings. Using a case-control design, this study estimated the incidence, risk factors, and outcomes of dehydration in adults admitted to the hospital. The overall prevalence rate for three International Classification of Diseases codes for dehydration at admission was 0.55%. Cases and controls differed significantly on a number of clinical variables at admission, including weight, body mass index, pulse, blood pressure, use of bulk-forming laxatives, serum sodium and chloride, and presence of generalized weakness or hemiplegia, edema, diarrhea, vomiting, and having nothing by mouth before admission. Mortality rates at 30 and 180 days after discharge were not significantly different between the two groups. Dehydration in community-dwelling adults may delay rehabilitation or result in hospital admission. Prevention, monitoring, and management are critical to preventing dehydration-associated problems.

People age 65 and older have more hospital stays than any other age group. Older adults make up approximately 12% of the U.S. population but account for one out of three hospital stays (13.2 million hospitalizations in 2003; Russo & Elixhauser, 2006). Older adults also have a high rate of chronic illness. A recent analysis estimated that 65% of the Medicare population has two or more chronic conditions (24% have four or more conditions; Wolff, Starfield, & Anderson, 2002). Similar to the Medicare population, patients treated at Veterans Affairs (VA) medical centers are older and have multiple chronic conditions (Ashton, Petersen, Wray, & Yu, 1998). Having multiple chronic illnesses significantly increases the likelihood of incurring an inpatient admission for ambulatory care sensitive conditions (ACSCs). ACSCs are defined as conditions for which timely and effective primary care may help reduce the risks of hospitalization by preventing the onset of a condition, controlling an acute episodic illness, or managing a chronic condition. Examples of ACSCs include both chronic illnesses such as diabetes, asthma, and heart failure, and acute conditions such as pneumonia, urinary tract infections, and dehydration (Kruzikas et al., 2004).

Rehabilitation nurses provide care for older adults across a variety of healthcare settings, including outpatient rehabilitation facilities, home healthcare agencies, and clinics. People in these settings often have multiple chronic conditions and functional limitations that are associated with an increased risk for development of dehydration and subsequent admission. Dehydration is associated with significantly longer stays in rehabilitation settings (Mukand, Cai, Zielinski, Danish, &

Berman, 2003), and therefore it may delay rehabilitation or result in hospital admission.

Dehydration is a common water and electrolyte disorder, but the clinical outcomes in older adults are much more serious than those in younger adults. In 1991, 6.7% (731,695) of all Medicare hospital admissions had dehydration as one of five diagnoses, and 1.4% (146,960) of admissions had dehydration as the principal diagnosis. Of those admitted with a principal diagnosis of dehydration, 18% died within 30 days, and an additional 30.6% died within 1 year of being hospitalized (Warren et al., 1994). The total amount reimbursed to hospitals for treatment of Medicare beneficiaries with dehydration as a principal diagnosis was more than \$446 million (Warren et al.). More recent estimates place the potential savings from avoiding dehydration admissions at more than \$1 billion (Xiao, Barber, & Campbell, 2004). From 1994 through 2000, admission rates for dehydration remained stable, ranging from 130 to 134 admissions per 100,000 population. However, women were hospitalized for dehydration at a higher rate than men (11% higher), and rural residents were hospitalized at a rate 37% higher than their urban counterparts (Kruzikas et al., 2004).

The hospital admission rate for dehydration is one of the Agency for Healthcare Research and Quality Prevention's Quality Indicators, which are considered screening tools for potential quality problems. Thus, admission for dehydration may reflect the quality of care provided in community settings. Prevention of dehydration in ambulatory settings requires knowledge of the risk factors for and signs and symptoms of dehydration in order to prevent its occurrence, institute early treatment, and prevent progression to

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more severe dehydration, which may necessitate expensive and potentially avoidable hospitalization. However, most work to date has focused on dehydration in long-term care settings (Culp et al., 2004; Kayser-Jones, 2006; Kayser-Jones, Schell, Porter, Barbaccia, & Shaw, 1999; Menten, 2006b; Menten & Culp, 2003). The purpose of this study was to describe prevalence estimates and patient factors (predisposing factors, signs and symptoms, and mortality) associated with hospital admission for a principal diagnosis of three dehydration codes: 276.0, hyperosmolality or hypernatremia; 276.1, hypo-osmolality or hyponatremia; and 276.5, volume depletion (Weinberg & Minaker, 1995).

Background

Dehydration is believed to be prevalent in older adults (Chidester & Spangler, 1997; Hoffman, 1991; Kositzke, 1990). However, no absolute definition of dehydration exists (Hodgkinson, Evans, & Wood, 2003; Weinberg & Minaker, 1995), and proposed definitions of dehydration vary. One definition includes rapid weight loss of more than 3% of body weight, serum sodium greater than 148 mmol/L, and blood urea nitrogen (BUN)/creatinine ratio greater than or equal to 25 (Hodgkinson et al.). Stookey, Pieper, and Cohen (2005) defined dehydration using the BUN/creatinine ratio, serum sodium, orthostatic blood pressure, and plasma osmolality. Although many define dehydration using the BUN/creatinine ratio, this ratio can be altered by mechanisms unrelated to dehydration (Robinson & Weber, 2004).

Determining the presence of dehydration involves assessing the patient's history, clinical signs, and laboratory data. Risk factors for dehydration include age (i.e., very young or old), although this assertion is controversial (Hodgkinson et al., 2003). Mobility and functional disability (including cognitive impairment) may be risk factors, primarily because dependent people are more likely to need assistance with eating and fluid intake (Hodgkinson et al.). Gender may be a risk factor, but there are conflicting opinions about whether females (Stookey et al., 2005) or males (Weinberg & Minaker, 1995) are at higher risk. Race may be related to increased risk, but the mechanism is unclear (Stookey et al.). Incontinence can be a risk factor for dehydration, in part because of a conscious decision by incontinent people to limit fluid intake (Hodgkinson et al.). Other risk factors include number of chronic illnesses, number of medications, number of opportunities for fluid intake, institutionalization (Hodgkinson et al.), vomiting and diarrhea, acute infections, and depression.

Though not uncommon, dehydration can be difficult to diagnose (Robinson & Weber, 2004; Thomas, Tariq, Makhdomm, Haddad, & Moinuddin, 2004).

One reason it is difficult to diagnose is that such things as medication side effects and symptoms associated with acute illnesses (e.g., infection) may cause similar symptoms (Feinsod et al., 2004). In patients presenting to the emergency room, signs of dehydration include sunken eyes, dry tongue with longitudinal furrows, dry mucous membranes of the mouth, upper body muscle weakness, speech difficulties, and confusion (Gross et al., 1992), although there is disagreement about the validity of these indicators (Robinson & Weber). Other symptoms include pronounced orthostatic blood pressure and tachycardia (Gross et al.; Robinson & Weber). Light-headedness and orthostasis may indicate volume depletion (Mange et al., 1997). Thirst may be an indicator of acute dehydration (Mange et al.), but thirst sensation may be blunted in older adults (Kenney & Chiu, 2001).

Laboratory indicators most frequently used to determine dehydration are the hematological indices, including serum sodium greater than 148 mmol/L, BUN/creatinine ratio of 25 or more, and serum osmolality greater than 295 mOsm/kg (Hodgkinson et al., 2003). BUN is a gross index of urea excretion that may increase in older adults when their kidneys cannot concentrate urine adequately. Likewise, increased creatinine may indicate impaired kidney function. Thus, an increase of both BUN and creatinine indicates kidney dysfunction. However, an increase in the BUN/creatinine ratio may signal chronic dehydration because urea, reabsorbed through the distal tubule, is more sensitive to dehydration than creatinine, which is reabsorbed in the proximal tubule. Because dehydration refers largely to intracellular water deficits, plasma osmolality is considered the gold standard measurement. Because plasma sodium is the major determinant of plasma osmolality, it serves as a marker for the diagnosis of dehydration (Mange et al., 1997; Thomas et al., 2004).

Urinary indices (e.g., urine color, specific gravity, osmolality) are considered less reliable indicators of dehydration because they do not correlate with the hematological indices (Weinberg & Minaker, 1995). In older adults with age-related decline in urinary-concentrating ability, neither urine osmolality nor urine-specific gravity can be used as a gold standard. These changes may represent the body's response to dehydration, that is, the downstream manifestation of compensatory responses to an already existing dehydration, or may represent early predictors or precursors of hypohydration (Francesconi et al., 1987; Menten et al., 2000; Menten, Wakefield, & Culp, 2006).

Outcomes of dehydration include hospital admission, functional decline (e.g., delirium; Foreman, Wakefield, Culp, & Milisen, 2001; Inouye et al., 1999; Reyes-Ortiz, 1997; Wakefield, Menten, Diggelmann, & Culp, 2002), and death. Mortality estimates in patients hospitalized with hypernatremia are as high as 41% (Chassagne,

Druesne, Capet, Menard, & Bercoff, 2006; Molaschi et al., 1997; Palevsky, Bhagrath, & Greenberg, 1996).

Methods

This study used a case-control design. In this design, subjects with the disease or condition of interest (cases) and those without the disease or condition (controls) were selected. The proportions of subjects who had risk factors and outcomes of interest in the two groups were determined and compared (Liberatos, Link, & Kelsey, 1988).

Subjects and Setting

Before data collection, the study was approved by the University of Iowa institutional review board, which serves the Iowa City VA Medical Center. The center provides outpatient and inpatient medical, surgical, psychiatric, and neurological care to more than 36,000 veterans residing in eastern Iowa and western Illinois. It serves as a referral center for several specialty services.

Medical records of patients admitted to the hospital between 1995 and 2000 were eligible for inclusion. The VA Patient Treatment File was used to generate a list of records. The Patient Treatment File is a VA database containing records of all hospital admissions to VA facilities. Because there is no agreed-upon definition of dehydration, for this study a case was defined as a patient with one of three International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes as the principal diagnosis (i.e., reason for admission). The three principal diagnosis ICD-9-CM codes were 276.0, hyperosmolality or hyponatremia; 276.1, hypo-osmolality or hyponatremia; and 276.5, volume depletion (Weinberg & Minaker, 1995).

In hyponatremic dehydration (ICD code 276.0), water losses are greater than sodium losses. Characteristics include hyponatremia (serum sodium levels greater than 145 mmol/L) and hyperosmolality (serum osmolality greater than 300 mmol/kg). This type is commonly caused by fever and an inability to increase oral intake. In hypo-osmolality or hyponatremia (ICD code 276.1), sodium loss exceeds water loss, reflected by serum sodium levels less than 135 mmol/L and hypo-osmolality (serum osmolality less than 280 mmol/kg). This type may be a result of overuse of diuretics causing excess sodium loss, as in patients with heart failure (Gupta & Neyses, 2005; Oren, 2005). The third type, hypovolemia or volume depletion (ICD code 276.5), results from balanced loss of water and sodium. This type is commonly associated with a complete fast or prolonged vomiting and diarrhea. Combinations of these three types can also occur (e.g., continuing diuretics while a patient has diarrhea).

Control patient records were randomly selected from all admissions without one of these three ICD-9-CM

codes listed (either at admission or during a hospital stay). Control patient records were matched to cases using three variables: age within 5 years, ward location, and admission month (within the same year).

Data Collection

Two abstractors, one physician and one clinical pharmacist, reviewed all study records using an investigator-developed chart abstraction tool that included 77 items reflecting demographic data, predisposing factors, and signs and symptoms of dehydration (Table 1). Items on the chart abstraction tool were based on a conceptual model (Figure 1) derived from a review of literature (Mentes et al., 2000) and clinical knowledge of dehydration.

The time period selected for the record review overlapped with the initial implementation of the electronic medical record in the VA, so both paper and electronic records were used in the review. Reviewers had access to the complete medical record, but the data for this study focused on information available for up to 72 hours before admission (i.e., data recorded in the admission history) and for the first 24 hours after the index admission to the hospital. In the case of multiple data points (e.g., multiple laboratory values in the first 24 hours after admission), the data point closest to hospital admission time was selected.

After initial training on the abstraction tool, interrater reliability between the two reviewers was established by having each abstractor individually review 10 records. These ratings were compared and each item was discussed (e.g., deciding where to find data when they were recorded multiple times, clarifying meaning of each item). The abstractors then reviewed 50 records, and the investigators again met to discuss ratings and modify the instrument to improve clarity. Periodic interrater reliability checks were conducted throughout data collection.

Once all data were collected, the data set was checked for out-of-range values and missing data. For the laboratory data, ranges were reviewed by a medical technologist and pathologist. Out-of-range values were verified by rereview of the medical record. To the extent they were available, missing data were identified by a rereview of the record. Data for deaths were obtained by merging the data set with data files at the VA Austin Automation Center using the Beneficiary Identification Records Locator Subsystem, a Veterans Benefits Administration database containing records of all beneficiaries, including veterans whose survivors applied for death benefits.

All data were analyzed using Statistical Analysis Software version 9.1. Student's *t* test was used to compare continuous variables (and Levine's test for unequal variances where appropriate); Pearson's chi-square was

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Table 1. Data Collection Variables

Demographic Data
Age
Gender
Race
Marital status
Height
Weight
Usual place of residence
History and Physical Findings
Vital signs on admission
Alcohol history
Smoking history
Weight loss in past 30 days
Skin turgor
Membrane hydration (oral mucosa)
Edema
Draining wounds or pressure ulcer
Permanent drains
In the past 30 days, has the patient had
upper respiratory infection
urinary tract infection
chemotherapy
radiation
dialysis
tracheostomy
oxygen therapy
Mental Status
Communication or comprehension difficulty
Swallowing problems
Dentition
Needs to be fed or needs help with eating
Activity and mobility level
Disability (hemiplegia, generalized weakness)
Food and Fluid Intake and Output History (up to 72 hours before admission)
Usual diet
Oral intake
Intravenous fluid intake
Fluid restriction
No food or tube feedings in past 72 hours
Feeding tube
Urine output
Urinary continence
Diarrhea
Constipation
Vomiting
Laboratory (first lab drawn at admission or within first 24 hours)
Sodium
Potassium
Chloride
Total carbon dioxide
Glucose
Blood urea nitrogen
Creatinine
Calcium
White blood cell count
Plasma osmolality
Urine-specific gravity
Urine osmolality
Urine sodium
Urine potassium

used to compare categorical variables. Records were grouped under each ICD-9 code, and each group was compared separately to the control group data. Because the medical records did not contain complete information for every variable of interest, we eliminated from the analysis variables for which data were missing for more than 25% of subjects. For example, the amount of urine output in the 72 hours before admission was generally not available. Therefore, results are reported for a subset of variables from the record review.

Results

During the 6-year study, there were 27,242 hospital admissions; 149 patients were admitted with one of three study ICD-9-CM codes as the reason for admission, resulting in an overall admission prevalence rate of 0.55%. Of the 149 patients, 4 (2.7%) had a principal diagnosis code of 276.0, 28 (18.8%) had a code of 276.1, and 117 (78.5%) had a code of 276.5. From the 149 admissions, data were obtained for 93 cases (62%). Records not reviewed include 40 records that were transferred elsewhere, 15 records that could not be located (patients admitted before implementation of the electronic record), and 1 restricted record. We obtained data for 91 control patients. The majority of the patients (88%) were admitted to medical units, with 10% admitted to surgical units and less than 1% admitted to the palliative care unit (unit location was missing for two subjects).

Overall, the mean age of the sample was 65 years ($SD = 11.7$ years), and, consistent with the population, 100% of patients were male. Because so few patients were identified with code 276.0, these subjects were deleted from further analysis. Demographic data for the three analyzed groups (controls and subjects with admission codes 276.1 and 276.5) are shown in **Table 2**. Reflecting the demographics of the population treated at this hospital, most patients were Caucasian. Most patients in the control group were admitted for the major diagnostic categories of circulatory system (24.2%), neoplasms (12.1%), nervous system (11%), and digestive system (9.9%).

Hyponatremic Group (ICD Code 276.1)

Compared with control patients, patients admitted for code 276.1 as the principal diagnosis were less likely to live at home before admission (76.5% vs. 95.5%, $p = .007$); were less likely to be married (23.4% vs. 50%, $p = .04$; **Table 2**); had significantly lower temperature (36.2°C compared with 36.7°C in controls), sodium (119.1 mEq/L compared with 136.9 mEq/L in controls), chloride (81.5 mmol/L compared with 99.8 mmol/L in controls), and urine-specific gravity (1.009 compared with 1.019 in controls; **Table 3**); and

were significantly more likely to be constipated (40% compared with 12.1% in controls), have generalized weakness, paraplegia, or hemiplegia (64.7% compared with 13.6% in controls), have altered urine output (increased or decreased; 50% compared with 9.1% of controls), and be taking thiazide diuretics (18.8% compared with 2.3% of controls; **Table 4**). The mean sodium and chloride values in the cases were below normal values (using sodium 135–145 mEq/L and chloride 95–107 mmol/L as normal ranges). Mortality rates at 30 and 180 days after discharge were not significantly different from those of control patients (**Table 5**).

Volume Depletion Group (ICD Code 276.5)

Compared with control patients, patients admitted for the code 276.5 as the principal diagnosis had significantly lower weight (76.6 kg compared with 87.9 kg in controls), body mass index (24.4 compared with 27.8 in controls), systolic (124 mm Hg compared with 140 mm Hg in controls) and diastolic (68 mm Hg compared with 73 mm Hg in controls) blood pressure, sodium (133.7 mEq/L compared with 136.9 mEq/L in controls), chloride (96.1 mmol/L compared with 99.8 mmol/L in controls), and higher pulse rate (85 compared with 79 in controls; **Table 3**). Cases were significantly more likely to have generalized weakness, paraplegia, or hemiplegia (47.8% compared with 13.6% in controls), diarrhea (22.9% compared with 5.5% in controls), vomiting (46.5% compared with 12.1% in controls), having nothing by mouth (NPO) before admission (12.5% compared with 3.3% in controls), and taking a bulk-forming laxative (11.6%

Table 1. Data Collection Variables (continued)

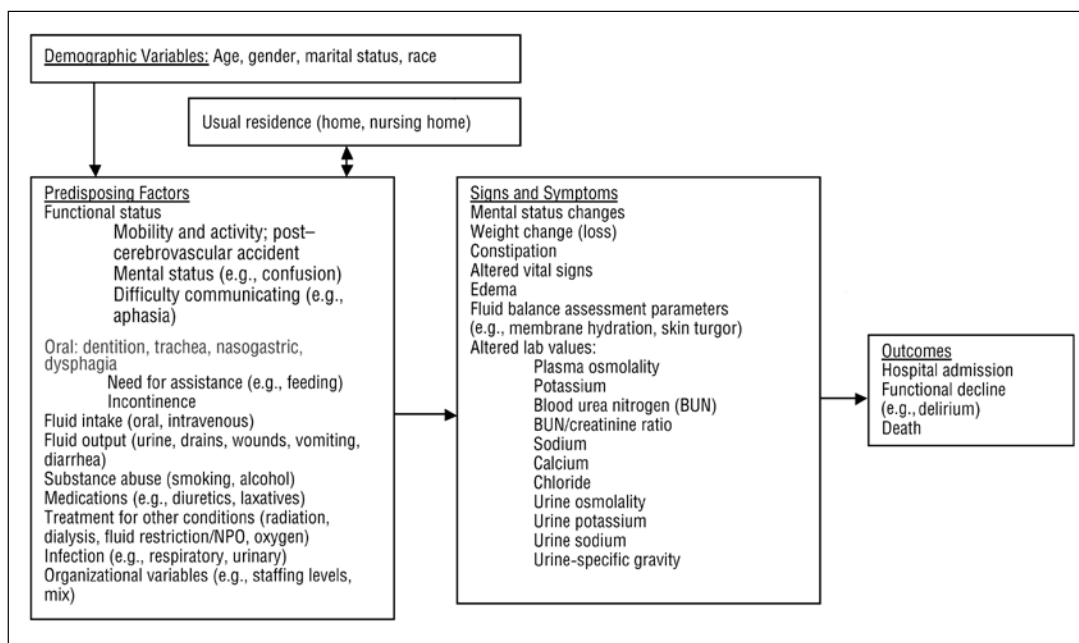
Medications on Admission
<i>Central nervous system</i>
Benzodiazepine derivatives
Sedatives and hypnotics
Tricyclic antidepressants
Monoamine oxidase inhibitors
Antidepressants, other
Phenothiazine and related antipsychotics
<i>Antipsychotics</i>
Lithium salts
Amphetamines
Amphetamine-like stimulants
<i>Diuretics</i>
Thiazides
Loop diuretics
Carbonic anhydrase inhibitors
Potassium sparing
Diuretics, other
<i>Laxatives</i>
Bulk-forming laxatives
Hyperosmotic laxatives
Lubricant laxatives
Stimulant laxatives
Stool softeners
Laxatives, other

compared with 1.2% in controls; **Table 4**). Cases were less likely to have edema (13.9% compared with 38.5% in controls; **Table 4**). Mortality rates at 30 and 180 days after discharge were not significantly different from those of control patients (**Table 5**).

Discussion

The admission rate for one of the three diagnosis codes in this population was a small percentage of all hospital admissions. Compared with control

Figure 1. Conceptual Model Guiding Data Collection



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Table 2. Sample Demographics

	Controls (<i>n</i> = 91)	Hypo-Osmolality or Hyponatremia (276.1) (<i>n</i> = 17)	Volume Depletion (276.5) (<i>n</i> = 72)
Mean age in years (<i>SD</i>)	65.0% (10.2)	69.2% (9.3)	64.4% (12.0)
Male	100.0%	100.0%	100.0%
Caucasian	95.6%	94.1%	100.0%
Married	50.0%	23.5% ¹	53.5%
Usual residence (home)	95.5%	76.5% ²	90.0%

¹*p* = .04; ²*p* = .007.

Table 3. Comparison of Admission Characteristics (Means) of Controls and Cases by Dehydration Type (Continuous Variables)

	Controls (<i>n</i> = 91)	Hypo-Osmolality or Hyponatremia (276.1) (<i>n</i> = 17)	<i>p</i>	Volume Depletion (276.5) (<i>n</i> = 72)	<i>p</i>
Weight (kg)	87.9	76.6	ns	76.6	.002
Body mass index	27.8	24.3	ns	24.4	.002
Temperature (°C)	36.7	36.2	.04	36.7	ns
Pulse	79	82	ns	85	.030
Systolic blood pressure (mm Hg)	140	143	ns	124	<.0001
Diastolic blood pressure (mm Hg)	73	73	ns	68	.029
Sodium (mEq/L)	136.9	119.1	<.0001	133.7	.001
Chloride (mmol/L)	99.8	81.5	<.0001	96.1	.001
Blood urea nitrogen (mg/dl)	25.9	24.0	ns	33.5	ns
Creatinine (mg/dl)	1.7	1.1	ns	1.8	ns
Blood urea nitrogen/creatinine ratio	18.4	19.5	ns	20.7	ns
White blood cell count	9.4524	10.681	ns	9.4471	ns
Urine-specific gravity	1.0186	1.009	.007	1.0149	ns

patients, patients admitted with hypo-osmolality or hyponatremia (276.1) had lower temperature, sodium (outside the range of normal), chloride (outside the range of normal), and urine-specific gravity and were significantly more likely to be constipated, have generalized weakness, have altered urine output, and be taking thiazide diuretics. Because thiazide diuretics inhibit reabsorption of sodium and chloride, this group of patients may have developed hyponatremia associated with use of diuretics.

Patients admitted with volume depletion (276.5) had lower weight, body mass index, blood pressure, sodium, and chloride, and higher pulse rates. They were also more likely to have generalized weakness, diarrhea, or vomiting, been NPO before admission, and be taking a bulk-forming laxative and were less likely to have edema. It is possible these patients were experiencing acute volume depletion (e.g., associated with vomiting and diarrhea). Acute dehydration, the most likely cause of admission in this group, is a loss of water and sodium, often caused by vomiting, diarrhea, sweating, blood loss, or fluid accumulation in body spaces where it cannot be drawn back into circulation. In contrast,

chronic dehydration is a fluid imbalance of a longer period; in older adults it is usually caused by insufficient fluid intake and occurs most commonly in long-term care or in unsupervised community-dwelling adults. Chronic dehydration causes fluid deficits in the cells, leading to altered absorption of medications, delirium, weakness, fatigue, exacerbation of medical conditions, and increased risk of death. The consequences of a chronically underhydrated state are delirium, urinary and respiratory infections, falls, constipation, and medication toxicity, all of which could precipitate a preventable hospitalization indirectly related to dehydration.

Almost none of the patients in this population were admitted for hypernatremia. In a previously published study, hypernatremia accounted for 0.2% of all admissions. In that study, compared with patients who developed hypernatremia after admission (iatrogenic), patients admitted to the hospital with hypernatremia (using a cutoff score of serum sodium greater than 150 mmol/L) were significantly older and more likely to be admitted from a nursing home (Palevsky et al., 1996). Hypernatremia is associated with a lack of access to free water (Chassagne et al., 2006; Palevsky et al.), so the low

Table 4. Comparison of Admission Characteristics of Controls Cases by Dehydration Type (Categorical Variables)

	Controls (n = 91)	Hypo-Osmolality or Hyponatremia (276.1) (n = 17)	p	Volume Depletion (276.5) (n = 72)	p
Constipation	12.1%	40.0%	.006	10.3%	ns
Disability (generalized weakness, hemiplegia)	13.6%	64.7%	<.0001	47.8%	<.0001
Urine output altered (increased or decreased)	9.1%	50.0%	<.001	20.4%	ns
Edema (yes)	38.5%	35.3%	ns	13.9%	.001
Diarrhea (yes)	5.5%	0.0%	ns	22.9%	.001
Vomit	12.1%	5.9%	ns	46.5%	<.0001
NPO	3.3%	0.0%	ns	12.5%	.034
Thiazides	2.3%	18.8%	.005	5.8%	ns
Bulk-forming laxatives	1.2%	0.0%	ns	11.6%	.006

Table 5. 30-Day and 6-Month Mortality by Status

	Controls	Hypo-Osmolality or Hyponatremia (276.1)	p	Volume Depletion (276.5)	p
30 days after discharge	4.4% (4)	5.9% (1)	ns	1.4% (1)	ns
6 months after discharge	15.4% (14)	11.8% (2)	ns	16.7% (12)	ns

rate in our study may reflect the population (i.e., most were admitted from home). Increased mortality is associated with hypernatremia, and we found no evidence of increased mortality in our sample.

From 1995 to 2000, the percentage of patients admitted for dehydration increased from 0.3% to 0.8%. This is a lower percentage than that reported by Warren and colleagues (1994; 1.4%) for Medicare admissions. Although the percentage admitted increased in a linear fashion over time, over this same period the total number of hospital admissions decreased. Thus, the rate of increase is probably due to the VA's efforts to shift from a system focused on inpatient care to one focused on improved management in outpatient care, resulting in only the sickest patients being admitted, as opposed to a true increase in the prevalence of admissions for dehydration.

Limitations

There are several limitations to this study. The most salient limitation is using existing medical records as the data source. In particular, missing data are a concern. It is unknown whether data are missing because the patient did not exhibit a characteristic, the patient did not report the symptom (e.g., history of alcohol use), or the clinician did not recognize or record the symptom. Furthermore, it is not possible to validate the information contained in the record (Krowchuk, Moore, & Richardson, 1995). It is possible there were unrecognized cases of dehydration in the group of control patients (misclassification bias). Although cases and controls were matched on several variables, a measure of severity of illness was not used.

The sample was male and limited to patients treated in a VA facility. Regarding gender differences, women

have a lower total body fluid to body weight ratio than men (Mentes, 2006a). Studies reporting gender differences in dehydration have mixed findings. In a study assessing hydration status in nursing home residents, estimated creatinine clearance levels were lower in women, and only 33% of women in the sample had adequate renal function, compared with 58% of men (Mentes et al., 2006). Using a large epidemiologic database, other investigators found the prevalence of hypertonicity, an indicator of cell dehydration, to be significantly higher in men; those with hypertonicity were more likely to exhibit clinical signs of dehydration, such as elevated creatinine and BUN/creatinine ratios (Stookey, 2005). Using separate large national databases, investigators have reported higher hospitalization rates for dehydration in men (Warren et al., 1994) and women (Kruzikas et al., 2004; Xiao et al., 2004).

All data were collected from records in one VA medical center, so findings may be biased by the admission policies and medical practice approach in that setting. Furthermore, compared with the general population, patients seen at VA facilities have higher rates of chronic illness such as diabetes (Pogach et al., 1998) and therefore may be at higher risk for dehydration.

Implications for Rehabilitation Nursing

Why is it important to recognize dehydration? Dehydration is associated with a number of major adverse outcomes, including delirium (Mentes et al., 1998) and death. Dehydration can affect medication metabolism, resulting in potential adverse drug events. Risk factors for dehydration and several geriatric syndromes are similar. For example, risk factors for delirium include age, severe illness, dementia, physical frailty, infection,

Key Practice Points

1. Risk factors for and signs and symptoms differ between hyponatremic and volume depletion (hypovolemic) dehydration.
2. Key symptoms in patients with hyponatremia are abnormal sodium, chloride, urine-specific gravity and altered urine output. Patients taking thiazide diuretics may be at risk for developing hyponatremia.
3. Key symptoms in patients with volume depletion are low blood pressure and abnormal sodium and chloride. Volume depletion may result from diarrhea, vomiting, and lack of fluid intake.
4. Nursing interventions need to be tailored to the individual's risk factors (e.g., medication management, fluid management, symptoms).

dehydration, polypharmacy, and renal impairment (Foreman et al., 2001). Risk factors for falls include advanced age, chronic disease, muscle weakness, and altered mental status (Perell et al., 2001). Patients with dehydration in this study had higher rates of muscle weakness and hemiplegia. Although there is some controversy and lack of agreement on what constitutes adequate fluid intake in older adults (Culp, Mentis, & Wakefield, 2003; Gaspar, 1999; Valtin, 2002), prevention includes simple measures such as ensuring adequate fluid intake and careful attention to medications. Medication monitoring is especially important for patients taking medications known to affect fluid balance (i.e., diuretics). Prevention, monitoring, and management are critical to preventing dehydration-associated problems.

Despite the risk of dehydration in older populations, very little research has addressed the risk factors for and clinically reliable indicators defining dehydration. Increasingly, electronic records are being implemented in healthcare settings. To the extent that documentation is more standardized in an electronic record (e.g., use of templates for admission assessment data and progress notes), future studies using electronic patient record data across multiple sites may allow greater insight into risk factors for and indicators of dehydration. People residing in rural areas have higher rates of admission for dehydration (Kruzikas et al., 2004). Thus, using remote monitoring (e.g., telehealth) for at-risk frail older adults (i.e., those living alone, those with hemiplegia) should be investigated as a means for closer monitoring of at-risk people who have limited access to healthcare services (Buckwalter, Davis, Wakefield, Kienzle, & Murray, 2002). Using a urine color chart should be further investigated as a

tool for community-dwelling older adults to monitor for dehydration (Mentes et al., 2006; Wakefield et al., 2002). Finally, nursing interventions tailored for the individual's risk factors (e.g., medication management, fluid management) must be tested for efficacy (Wakefield, 2008).

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References

- Ashton, C. M., Petersen, N. J., Wray, N. P., & Yu, H. J. (1998). The Veterans Affairs medical care system: Hospital and clinic utilization statistics for 1994. *Medical Care*, 36(6), 793-803.
- Buckwalter, K., Davis, L., Wakefield, B. J., Kienzle, M. G., & Murray, M. A. (2002). Telehealth for elders and their caregivers in rural communities. *Family & Community Health*, 25(3), 31-40.
- Chassagne, P., Druesne, L., Capet, C., Menard, J. F., & Bercoff, E. (2006). Clinical presentation of hypernatremia in elderly patients: A case control study. *Journal of the American Geriatrics Society*, 54(8), 1225-1230.
- Chidester, J. C., & Spangler, A. A. (1997). Fluid intake in the institutionalized elderly. *Journal of the American Dietetic Association*, 97(1), 23-28.
- Culp, K., Mentis, J., & Wakefield, B. (2003). Hydration and acute confusion in long-term care residents. *Western Journal of Nursing Research*, 25(3), 251-266.
- Culp, K. R., Wakefield, B., Dyck, M. J., Cacchione, P. Z., DeCrane, S., & Decker, S. (2004). Bioelectrical impedance analysis and other hydration parameters as risk factors for delirium in rural nursing home residents. *Journals of Gerontology Series A: Biological Sciences & Medical Sciences*, 59A(8), 813-817.
- Feinsod, F. M., Levenson, S. A., Rapp, K., Rapp, M. P., Beechinor, E., & Liebmann, L. (2004). Dehydration in frail, older residents in long-term care facilities. *Journal of the American Medical Directors Association*, 5(2 Suppl.), S35-41.
- Foreman, M. D., Wakefield, B., Culp, K., & Milisen, K. (2001). Delirium in elderly patients: An overview of the state of the science. *Journal of Gerontological Nursing*, 27(4), 12-20.
- Francesconi, R. P., Hubbard, R. W., Szlyk, P. C., Schnakenberg, D., Carlson, D., Leva, N., et al. (1987). Urinary and hematologic indexes of hypohydration. *Journal of Applied Physiology*, 62(3), 1271-1276.
- Gaspar, P. M. (1999). Water intake of nursing home residents. *Journal of Gerontological Nursing*, 25(4), 23-29.

- Gross, C. R., Lindquist, R. D., Woolley, A. C., Granieri, R., Allard, K., & Webster, B. (1992). Clinical indicators of dehydration severity in elderly patients. *Journal of Emergency Medicine*, 10(3), 267-274.
- Gupta, S., & Neyses, L. (2005). Diuretic usage in heart failure: A continuing conundrum in 2005. *European Heart Journal*, 26(7), 644-649.
- Hodgkinson, B., Evans, D., & Wood, J. (2003). Maintaining oral hydration in older adults: A systematic review. *International Journal of Nursing Practice*, 9, S19-S28.
- Hoffman, N. B. (1991). Dehydration in the elderly: Insidious and manageable. *Geriatrics*, 46(6), 35-38.
- Inouye, S. K., Bogardus, S. T., Charpentier, P. A., Leo-Summers, L., Acampora, D., Holford, T. R., et al. (1999). A multicomponent intervention to prevent delirium in hospitalized older patients. *New England Journal of Medicine*, 340(9), 669-676.
- Kayser-Jones, J. (2006). Preventable causes of dehydration: Nursing home residents are especially vulnerable. *American Journal of Nursing*, 106(6), 45.
- Kayser-Jones, J., Schell, E. S., Porter, C., Barbaccia, J. C., & Shaw, H. (1999). Factors contributing to dehydration in nursing homes: Inadequate staffing and lack of professional supervision. *Journal of the American Geriatrics Society*, 47(10), 1187-1194.
- Kenney, W. L., & Chiu, P. (2001). Influence of age on thirst and fluid intake. *Medicine & Science in Sports & Exercise*, 33(9), 1524-1532.
- Kositzke, J. A. (1990). A question of balance: Dehydration in the elderly. *Journal of Gerontological Nursing*, 16(5), 4-11.
- Krowchuk, H., Moore, M. L., & Richardson, L. (1995). Using health care records as sources of data for research. *Journal of Nursing Measurement*, 3(1), 3-12.
- Kruzikas, D. T., Jiang, H. J., Remus, D., Barrett, M. L., Coffey, R. M., & Andrews, R. (2004). *Preventable hospitalizations: A window into primary and preventive care 2000*. HCUP Fact Book No. 5; AHRQ Publication No. 04-0056. Rockville, MD: Agency for Healthcare Research and Quality.
- Liberatos, P., Link, B. G., & Kelsey, J. L. (1988). The measurement of social class in epidemiology. *Epidemiologic Reviews*, 10, 87-121.
- Mange, K., Matsuura, D., Cizman, B., Sota, H., Ziyadeh, F., Goldfarb, S., et al. (1997). Language guiding therapy: The case of dehydration versus volume depletion. *Annals of Internal Medicine*, 127(9), 848-853.
- Mentes, J. C. (2006a). Oral hydration in older adults. *American Journal of Nursing*, 106(6), 40-49.
- Mentes, J. C. (2006b). A typology of oral hydration problems exhibited by frail nursing home residents. *Journal of Gerontological Nursing*, 32(1), 13-19.
- Mentes, J. C., & Culp, K. (2003). Reducing hydration-linked events in nursing home residents. *Clinical Nursing Research*, 12(3), 210-225.
- Mentes, J. C., Culp, K., Wakefield, B., Gaspar, P., Rapp, C. G., Mobyly, P., et al. (1998). Dehydration as a precipitating factor in the development of acute confusion in the frail elderly. *Facts, Research and Intervention in Gerontology*, pp. 83-100.
- Mentes, J. C., Rapp, C. G., Wakefield, B., Culp, K., Tripp-Reimer, T., Mobyly, P., et al. (2000). Hydration management protocol. *Journal of Gerontological Nursing*, 26(10), 6-15.
- Mentes, J. C., Wakefield, B., & Culp, K. R. (2006). Use of a urine color chart to monitor hydration status in nursing home residents. *Biological Research for Nursing*, 7(3), 197-203.
- Molaschi, M., Ponzetto, M., Massaia, M., Villa, L., Scarafioti, C., & Ferrario, E. (1997). Hypernatremic dehydration in the elderly on admission to hospital. *Journal of Nutrition, Health & Aging*, 1(3), 156-160.
- Mukand, J. A., Cai, C., Zielinski, A., Danish, M., & Berman, J. (2003). The effects of dehydration on rehabilitation outcomes of elderly orthopedic patients. *Archives of Physical Medicine & Rehabilitation*, 84(1), 58-61.
- Oren, R. M. (2005). Hyponatremia in congestive heart failure. *American Journal of Cardiology*, 95(9A), 2B-7B.
- Palevsky, P. M., Bhagrath, R., & Greenberg, A. (1996). Hypernatremia in hospitalized patients. *Annals of Internal Medicine*, 124(2), 197-203.
- Perell, K. L., Nelson, A., Goldman, R. L., Luther, S. L., Prieto-Lewis, N., & Rubenstein, L. Z. (2001). Fall risk assessment measures: An analytic review. *Journals of Gerontology Series A: Biological Sciences & Medical Sciences*, 56(12), M761-766.
- Pogach, L. M., Hawley, G., Weinstock, R., Sawin, C., Schiebe, H., Cutler, F., et al. (1998). Diabetes prevalence and hospital and pharmacy use in the Veterans Health Administration (1994). Use of an ambulatory care pharmacy-derived database. *Diabetes Care*, 21(3), 368-373.
- Reyes-Ortiz, C. A. (1997). Dehydration, delirium, and disability in elderly patients [comment]. *JAMA*, 278(4), 287-288.
- Robinson, B. E., & Weber, H. (2004). Dehydration despite drinking: Beyond the BUN/creatinine ratio. *Journal of the American Medical Directors Association*, 5(2 Suppl.), S67-71.
- Russo, C. A., & Elixhauser, A. (2006). *Hospitalizations in the elderly population, 2003*. Statistical Brief #6. Rockville, MD: Agency for Healthcare Research and Quality.
- Stookey, J. D. (2005). High prevalence of plasma hypertonicity among community-dwelling older adults: Results from NHANES III. *Journal of the American Dietetic Association*, 105(8), 1231-1239.
- Stookey, J. D., Pieper, C. F., & Cohen, H. J. (2005). Is the prevalence of dehydration among community-dwelling older adults really low? Informing current debate over the fluid recommendation for adults aged 70+ years. *Public Health Nutrition*, 8(8), 1275-1285.
- Thomas, D. R., Tariq, S. H., Makhdomm, S., Haddad, R., & Moinuddin, A. (2004). Physician misdiagnosis of dehydration in older adults. *Journal of the American Medical Directors Association*, 5(2 Suppl.), S30-34.
- Valtin, H. (2002). "Drink at least eight glasses of water a day." Really? Is there scientific evidence for "8 ↔ 8"? *American Journal of Physiology: Regulatory Integrative & Comparative Physiology*, 283(5), R993-1004.
- Wakefield, B. J. (2008). Fluid management. In G. L. E. Ackley, B. Swan, & S. Tucker (Eds.), *Evidence-based nursing care guidelines: Medical-surgical interventions* (pp.375-382). New York: Elsevier.
- Wakefield, B., Menten, J., Diggelmann, L., & Culp, K. (2002). Monitoring hydration status in elderly veterans. *Western Journal of Nursing Research*, 24(2), 132-142.
- Warren, J. L., Bacon, W. E., Harris, T., McBean, A. M., Foley, D. J., & Phillips, C. (1994). The burden and outcomes associated with dehydration among US elderly, 1991. *American Journal of Public Health*, 84(8), 1265-1269.
- Weinberg, A. D., & Minaker, K. L. (1995). Dehydration: Evaluation and management in older adults. *JAMA*, 274(19), 1552-1556.
- Wolff, J. L., Starfield, B., & Anderson, G. (2002). Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. *Archives of Internal Medicine*, 162(20), 2269-2276.
- Xiao, H., Barber, J., & Campbell, E. S. (2004). Economic burden of dehydration among hospitalized elderly patients. *American Journal of Health-System Pharmacy*, 61(23), 2534-2540.

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