

# The Burden and Outcomes Associated with Dehydration among US Elderly, 1991

## ABSTRACT

**Objectives.** Dehydration has been underappreciated as a cause of hospitalization and increased hospital-associated mortality in older people. This study used national data to analyze the burden and outcomes following hospitalizations with dehydration in the elderly.

**Methods.** Data from 1991 Medicare files were used to calculate rates of hospitalization with dehydration, to examine demographic characteristics and concomitant diagnoses associated with dehydration, and to analyze the contribution of dehydration to mortality.

**Results.** In 1991, 6.7% (731 695) of Medicare hospitalizations had dehydration listed as one of the five reported diagnoses, a rate of 236.2/10 000 elderly Medicare beneficiaries. In 1991, Medicare reimbursed over \$446 million for hospitalizations with dehydration as the principal diagnosis. Older people, men, and Blacks had elevated risks for hospitalization with dehydration. Acute infections, such as pneumonia and urinary tract infections, were frequent concomitant diagnoses. About 50% of elderly Medicare beneficiaries hospitalized with dehydration died within a year of admission.

**Conclusions.** Hospitalization of elderly people with dehydration is a serious and costly medical problem. Attention should be focused on understanding predisposing factors and devising strategies for prevention. (*Am J Public Health.* 1994;84:1265-1269)

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### Introduction

Dehydration is a common condition in the elderly, and, in 1991, dehydration was 1 of the 10 most frequent diagnoses reported for Medicare hospitalizations (Health Care Financing Administration [HCFA], unpublished data). Dehydration has been reported previously as the reason for hospitalization in 0.65% and 2.25% of all admissions to two hospitals.<sup>1</sup> In a case series of 15 187 hospital admissions in a single hospital, 1.1% of patients 60 years of age and older were found to have hypernatremia.<sup>2</sup> These studies, from a limited number of hospitals, highlight the lack of published information on hospitalizations with dehydration, including the incidence of dehydration in the elderly population, patterns of mortality, and concomitant health conditions. As the number of elderly people increases—especially the oldest old, who appear to be more prone to dehydration<sup>3-5</sup>—the importance of dehydration as a medical condition is likely to increase. Examination of national data on hospitalizations among the elderly can help delineate the extent of the burden resulting from dehydration and promote the need for strategies to prevent morbidity, mortality, and costs associated with this condition.

In this paper, we examine hospitalizations with dehydration among people 65 years of age and older. We first examine the burden of dehydration in the elderly by presenting the rates of hospitalizations with dehydration in 1991 as well as identifying specific demographic groups at risk of hospitalization for dehydration and at risk of dying within 30 days of admission. We then explore areas for potential interventions that might lessen the impact of dehydration. This analysis includes the identification of concomitant

diagnoses that are reported frequently for hospitalizations with dehydration, which may improve understanding of the causes of this condition. In addition, we estimate the effect of dehydration on mortality by comparing, for 10 groups of principal diagnoses, early and late mortality following hospitalizations with and without dehydration as a concomitant diagnosis.

### Methods

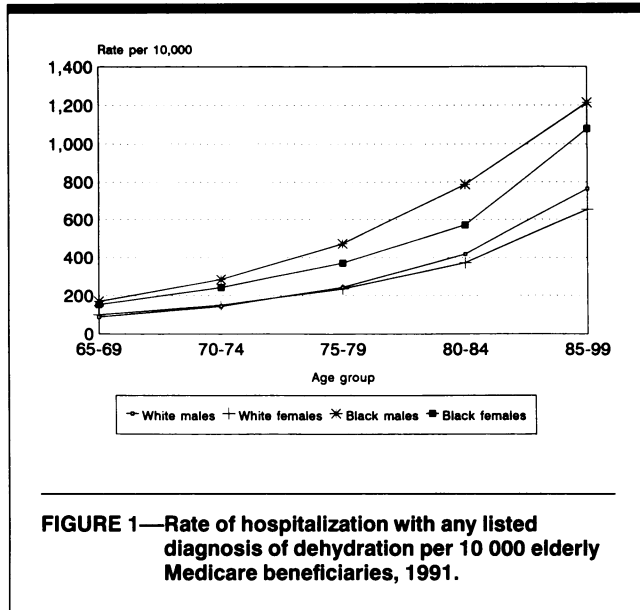
Data for this project were obtained from the Medicare Provider Analysis and Review (MEDPAR) files maintained by HCFA. These files, which are available from 1984 to the present, contain summarized records of all claims submitted by hospitals for services provided to Medicare beneficiaries. For each hospitalization, the MEDPAR record contains information about the beneficiary's age, race, and sex; up to five diagnoses classified according to the *International Classification of Diseases, 9th Revision, Clinical*

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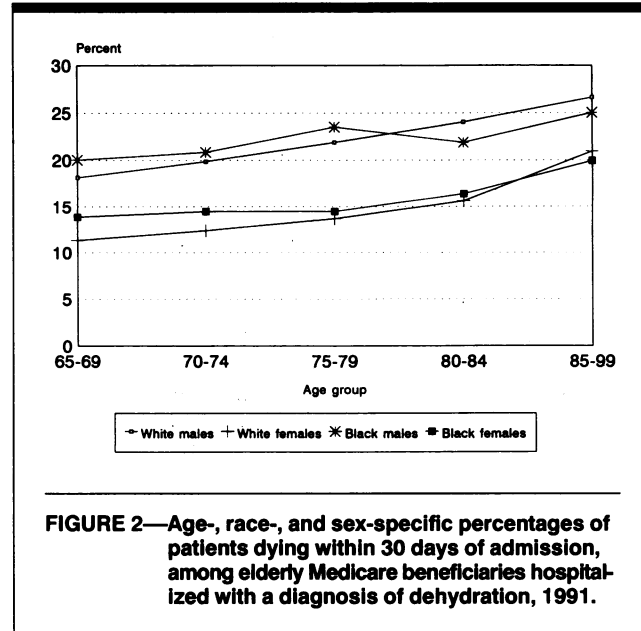
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**Note.** The views expressed here are the authors' and do not necessarily reflect those of the Health Care Financing Administration, the National Center for Health Statistics, or the National Institute on Aging.



**FIGURE 1—Rate of hospitalization with any listed diagnosis of dehydration per 10 000 elderly Medicare beneficiaries, 1991.**



**FIGURE 2—Age-, race-, and sex-specific percentages of patients dying within 30 days of admission, among elderly Medicare beneficiaries hospitalized with a diagnosis of dehydration, 1991.**

Modification (ICD-9-CM)<sup>6</sup>; the amount reimbursed to the hospital by Medicare and the dates of admission and discharge; and the date of death (reported by the Social Security Administration) if death occurred within 2 years after the year of hospitalization.

Dehydration is a condition with multiple causes,<sup>1,7-10</sup> and the term is commonly used to reflect several related physiological states based on an imbalance between intake and loss of fluid and the accompanying sodium status.<sup>4,10,11</sup> The present study included as cases all hospitalizations involving an ICD-9-CM code for volume depletion (276.5), regardless of sodium status, since in most cases sodium status was not reported. Medicare beneficiaries who were hospitalized in 1991 with dehydration were identified from a review of a 20% random sample of all hospitalizations. All records with an ICD-9-CM diagnosis of volume depletion appearing as the principal or as a concomitant diagnosis were selected. (The principal diagnosis is the diagnosis that, after thorough review, is believed by the physician to be the cause for the hospitalization.) We use the phrase “hospitalization with dehydration” to refer to cases with dehydration as one of the five diagnoses; “hospitalization for dehydration” refers to those with dehydration as the principal diagnosis. We limited our analysis to Black and White Medicare beneficiaries who were 65 to 99 years of age and resided in 1 of the 50 states or the District of Columbia. We excluded the estimated 5% to 6% of Medicare beneficiaries who were enrolled in a health maintenance organi-

zation (HMO) at the time of hospitalization because Medicare utilization records for HMO enrollees are incomplete.

The rate of hospitalization with dehydration in 1991 was calculated per 10 000 elderly beneficiaries enrolled in Medicare’s hospitalization insurance program (Part A) as of July 1 of that year. Preliminary data showed an interaction effect between increasing age and sex on rates of hospitalization with dehydration; therefore, we calculated age-, race-, and sex-specific rates. Comparisons between all possible combinations of strata were made (i.e., rates for age between each race-sex group, rates for sex between each race-age group, and rates for race between each sex-age group). The method described by Kahn and Sempos<sup>12</sup> was used to calculate the relative risk and surrounding 95% confidence interval for each comparison. The respective reference groups for each of the comparisons were individuals 65 to 69 years of age, men, and Whites. The proportion of people who died within 30 days of being admitted to the hospital with dehydration was calculated for each age, race, and sex group, and comparisons were made as described above.

To determine the cost to Medicare, we totaled the amount reimbursed in 1991 by HCFA for hospitalizations with dehydration as the principal diagnosis. The average cost per hospitalization was determined from the median amount reimbursed by HCFA per hospitalization for dehydration as the principal diagnosis. We were unable to determine from these

data the additional costs to Medicare for cases involving dehydration as a concomitant diagnosis.

We used the MEDPAR data to examine all diagnoses reported for hospitalizations with dehydration in 1991. To facilitate interpretability of the data, diagnoses were assigned to 1 of 10 categories based on ICD-9-CM codes. (The specific codes included in each diagnosis category are listed in the Appendix.) The frequency at which each diagnosis category occurred for hospitalizations with dehydration is presented. Because each record contains up to five diagnoses, more than one diagnosis category may be present during a single hospitalization.

To examine the contribution of dehydration to mortality for selected principal diagnoses, death rates after hospitalization with a concomitant diagnosis of dehydration were compared with death rates after hospitalization with no concomitant diagnosis of dehydration. The 10 previously described diagnosis categories were used in classifying principal diagnoses. Hospitalizations without a concomitant diagnosis of dehydration were obtained from a 20% random sample of hospitalization records from 1991. For this comparison, the mortality rates were adjusted for race, sex, and age by the direct method, with the total number of beneficiaries hospitalized in 1991 as the standard population. Relative risks and surrounding 95% confidence intervals were calculated as described previously. Deaths occurring within 30 days of admission were considered as early mortality;

**TABLE 1—Frequency of Selected Diagnoses Reported for Hospitalizations with Any Listed Diagnosis of Dehydration among Elderly Medicare Beneficiaries, 1991**

| Diagnosis Category <sup>a</sup>   | Sample, % |
|-----------------------------------|-----------|
| Respiratory illness               | 28.2      |
| Urinary system infections         | 24.9      |
| Cardiac                           | 21.8      |
| Frailty                           | 20.3      |
| Other metabolic disorders         | 18.9      |
| Other gastrointestinal conditions | 18.8      |
| Cancer                            | 15.7      |
| Diabetes                          | 12.0      |
| Gastroenteritis                   | 10.4      |
| Sepsis                            | 7.1       |

<sup>a</sup>Diagnosis appears as one of five reported to Medicare; see Appendix for specific codes for each category.

those occurring between 31 and 365 days after admission were considered as late mortality.

## Results

In 1991, the rate of hospitalization per 10 000 elderly Medicare beneficiaries was 236.2 admissions with any listed diagnosis of dehydration and 49.7 admissions for dehydration as a principal diagnosis. Of the more than 10 million hospitalizations involving elderly Medicare beneficiaries during that year, 6.7% (731 695 hospitalizations) had a diagnosis of dehydration in any position and 1.4% (146 960 hospitalizations) had dehydration listed as the principal diagnosis.

There were significant differences in the rate of hospitalization with dehydration by age, race, and sex (Figure 1). Increasing age was a major factor in risk of admission with dehydration, with people 85 to 99 years of age more than 6 times more likely to be hospitalized for dehydration than those 65 to 69 years of age. At each age, Blacks were 1.5 to 2 times more likely than Whites to be hospitalized with dehydration. Within race, men were more likely to be admitted with dehydration than were women, except for Whites 65 to 79 years of age.

Overall, more than 18% of patients died within 30 days of hospitalization with dehydration. Mortality rates increased with age, even among the young old (those 65 to 74 years of age), and 30-day

**TABLE 2—Early and Late Mortality Rates for Selected Principal Diagnosis Categories among Elderly Medicare Beneficiaries Hospitalized with and without a Concomitant Diagnosis of Dehydration, 1991**

| Principal Diagnosis Category      | 30-Day Post-admission Mortality Rate <sup>a</sup> | Relative Risk (95% Confidence Interval) | 31- to 365-Day Post-admission Mortality Rate <sup>a</sup> | Relative Risk (95% Confidence Interval) |
|-----------------------------------|---|---|---|---|
| Dehydration                       | 17.4  | ...                                     | 30.6  | ...                                     |
| Respiratory illness               |   |   |   |   |
| Without dehydration <sup>b</sup>  | 10.9  | 1.00                                    | 17.7  | 1.00                                    |
| With dehydration                  | 18.9  | 1.73 (1.66, 1.79)                       | 23.9  | 1.35 (1.31, 1.39)                       |
| Gastroenteritis                   |   |   |   |   |
| Without dehydration <sup>b</sup>  | 3.1   | 1.00                                    | 12.7  | 1.00                                    |
| With dehydration                  | 3.3   | 1.07 (0.89, 1.30)                       | 14.7  | 1.16 (1.06, 1.26)                       |
| Other gastrointestinal conditions |   |   |   |   |
| Without dehydration <sup>b</sup>  | 4.9   | 1.00                                    | 10.2  | 1.00                                    |
| With dehydration                  | 8.8   | 1.79 (1.68, 1.91)                       | 18.1  | 1.78 (1.70, 1.86)                       |
| Urinary system infections         |   |   |   |   |
| Without dehydration <sup>b</sup>  | 7.2   | 1.00                                    | 18.2  | 1.00                                    |
| With dehydration                  | 11.5  | 1.58 (1.47, 1.70)                       | 29.6  | 1.62 (1.56, 1.69)                       |
| Cancer                            |   |   |   |   |
| Without dehydration <sup>b</sup>  | 14.1  | 1.00                                    | 25.9  | 1.00                                    |
| With dehydration                  | 45.2  | 3.20 (3.10, 3.30)                       | 40.4  | 1.56 (1.50, 1.62)                       |
| Sepsis                            |   |   |   |   |
| Without dehydration <sup>b</sup>  | 22.5  | 1.00                                    | 20.9  | 1.00                                    |
| With dehydration                  | 29.5  | 1.31 (1.25, 1.37)                       | 27.2  | 1.30 (1.23, 1.38)                       |
| Cardiac                           |   |   |   |   |
| Without dehydration <sup>b</sup>  | 10.4  | 1.00                                    | 14.9  | 1.00                                    |
| With dehydration                  | 22.8  | 2.19 (2.07, 2.31)                       | 26.5  | 1.78 (1.69, 1.88)                       |
| Frailty                           |   |   |   |   |
| Without dehydration <sup>b</sup>  | 16.9  | 1.00                                    | 25.4  | 1.00                                    |
| With dehydration                  | 25.5  | 1.51 (1.43, 1.60)                       | 36.1  | 1.42 (1.35, 1.49)                       |
| Diabetes                          |   |   |   |   |
| Without dehydration <sup>b</sup>  | 5.1   | 1.00                                    | 13.7  | 1.00                                    |
| With dehydration                  | 8.9   | 1.73 (1.50, 1.99)                       | 18.1  | 1.32 (1.20, 1.45)                       |
| Other metabolic disorders         |   |   |   |   |
| Without dehydration <sup>b</sup>  | 7.9   | 1.00                                    | 17.3  | 1.00                                    |
| With dehydration                  | 11.1  | 1.41 (1.20, 1.65)                       | 24.4  | 1.41 (1.27, 1.57)                       |

<sup>a</sup>Per 100 hospitalizations. Adjusted for age, race, and sex.

<sup>b</sup>Reference group.

postadmission mortality was about 12% for women and 18% for men. For each age-race stratum, the proportion of men dying was 26% to 63% higher than that of women (Figure 2). Comparison of data by race suggests that, for both sexes, the percentage of Blacks dying was higher up to 79 years of age but lower for the 85- to 99-year age range. The greatest difference between the race-sex groups was for Black women 65 to 69 years old, who had mortality rates 22% higher than White women in the same age group.

The total amount reimbursed by HCFA to hospitals for treatment of beneficiaries hospitalized for dehydration as the principal diagnosis was more than \$446 million. The median cost per hospi-

talization for dehydration as the principal diagnosis was \$2942.

A review of all diagnoses reported for hospitalizations with dehydration showed that a large number of patients with dehydration also had acute infections: 28.2% had a respiratory illness, 24.9% had a diagnosis of urinary system infection, 10.4% had a diagnosis of gastroenteritis, and 7.1% had a diagnosis of sepsis (Table 1). Chronic conditions such as frailty, cancer, and diabetes occurred in 20.3%, 15.7%, and 12.0% of hospitalizations, respectively.

Among people hospitalized with a principal diagnosis of dehydration, almost half died within a year of admission, with 17.4% dying within 30 days of admission

and an additional 30.6% dying in the remaining 11 months of the year (Table 2). For hospitalizations with dehydration as a concomitant condition, there was considerable variation in mortality based on the principal diagnosis. Comparison of mortality rates by principal diagnosis for hospitalizations with and without a concomitant diagnosis of dehydration showed that, for each principal diagnosis, hospitalizations with a concomitant diagnosis of dehydration involved significantly higher mortality for both the early and later periods, with the exception of deaths within 30 days of hospitalization for gastroenteritis.

## Discussion

These data demonstrate that dehydration in the elderly is a serious, frequent, and costly medical problem that may not have been fully recognized to date. Older people, men, and Blacks are more likely to be hospitalized for dehydration. Hospitalization resulting from dehydration is associated with an increased risk of death, particularly for older men. In 1991, Medicare payments were more than \$446 million for beneficiaries hospitalized with dehydration as a principal diagnosis. This figure does not include costs of treatment for the entire episode of care (physician visits, home health or skilled nursing care), care provided to beneficiaries enrolled in an HMO, or additional costs to Medicare for 584 735 non-HMO hospitalizations that involved dehydration as a complicating condition.

In this study, the 1.4% of hospitalizations with dehydration as the principal diagnosis is comparable to what has been reported in previous research.<sup>1,2</sup> Unlike prior researchers, we reviewed all diagnoses reported for each hospitalization. We found that 6.7% of all hospitalizations had dehydration listed as one of five diagnoses. This finding suggests that all diagnoses reported during a hospitalization should be reviewed to assess the full extent of dehydration as a problem among hospitalized elderly people.

In the present study, of people admitted with a principal diagnosis of dehydration, the percentage dying within 30 days of admission—17.42—was lower than the 46% to 48% reported for hospitalizations for hypernatremic dehydration.<sup>3,13</sup> The variation in mortality found between the present and previous studies may reflect differences in case definition or special characteristics of those with hypernatremia. However, pre-

vious studies have attributed high mortality rates not to the level of hypernatremia but to the significant underlying disease.<sup>3,13</sup> To address this issue, we stratified by principal diagnosis. From this stratification, it appears that the risk of mortality after hospitalization with dehydration varies considerably depending on principal diagnosis. However, for each principal diagnosis, the concomitant diagnosis of dehydration was associated with an increased risk of death.

The high rates of mortality suggest that hospitalization with dehydration should be considered a marker for an increased risk of death within the next year. We examined another common condition in the elderly, hip fracture, that has a high post-admission mortality rate and is often considered to place the person at increased risk of death within the year following the event. By comparison, mortality within 30 days of admission has been reported as 6.4% of hospitalizations with hip fracture<sup>14</sup> and 17.4% of hospitalizations with dehydration. Within 1 year, 20% of patients with hip fractures died,<sup>15</sup> in comparison with more than 47% of those with dehydration.

Recognizing the incidence, risks, and costs associated with dehydration raises the need for strategies to prevent the condition. Of the underlying diseases likely to cause dehydration, some appear preventable. Respiratory illnesses, which were diagnosed in more than 28% of those hospitalized with dehydration, could possibly be prevented or reduced by influenza and pneumococcal vaccination.<sup>16,17</sup> Yet, it is currently estimated that only 30% to 41% of individuals over age 65 are immunized annually against influenza, and only 14% to 20% have received a pneumococcal vaccination.<sup>18,19</sup> Other infectious diseases, although not as amenable to prevention, should be recognized as potential predisposing factors for dehydration among older people. For instance, dehydration associated with gastroenteritis may be prevented by prompt recognition of the gastroenteritis and intervention through fluid orders, including the use of oral rehydration or administration of intravenous fluids. Efforts to prevent dehydration should be directed toward educating elderly patients, especially those living alone, regarding the risk of dehydration and the need to maintain adequate oral intake during periods of acute illness. Nursing personnel should also be made aware of the importance of monitoring fluid intake in elderly patients in hospitals and nursing homes.

There are several limitations to our study. We cannot determine from the data whether the dehydration occurred prior to or during the hospitalization. In addition, we cannot ascertain from the Medicare data the clinical treatment that might have influenced dehydration outcomes (e.g., rapid rates of rehydration that might increase mortality).<sup>3</sup> Administrative data do not provide information on the underlying health status of people hospitalized with dehydration. While it appears that acute illness is associated with dehydration, it may be that these individuals also have chronic medical conditions that influence the risk and outcomes of dehydration.

The accuracy of secondary data in measuring the extent of dehydration may be questioned. However, the MEDPAR data used in the present study were validated from a second source, the National Hospital Discharge Survey. This survey, conducted annually by the National Center for Health Statistics (NCHS), includes data abstracted from the medical records of a representative sample of discharges from non-federal short-stay hospitals in the United States.<sup>20</sup> The survey data are subject to field quality checks for validity and reliability. For the years 1984 to 1991, a comparison of the data available from the survey and from MEDPAR revealed that the population-based rates of dehydration observed from both sources were essentially the same (HCFA and NCHS, unpublished data, 1984–1991).

In conclusion, this study provides the first national estimates that demonstrate the extent to which dehydration is a significant cause of morbidity, mortality, and health care costs in the elderly. Hospitalizations with dehydration are associated with acute illness, which suggests that some cases of dehydration may be preventable. Investigations in the clinical setting of specific diseases associated with dehydration may yield additional preventive strategies and sources of cost savings. Furthermore, rates of mortality after hospitalizations with dehydration both as a principal and as a concomitant diagnosis are high. People hospitalized with dehydration should be considered at increased risk for dying within the year following admission. Recognition by health care providers of the extent that dehydration is a problem in the elderly, prevention of the underlying causes, and prompt treatment of the early stages of dehydration may reduce the morbidity, mortality, and costs resulting from this condition. □

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**APPENDIX—ICD-9-CM Codes Used to Classify Diagnoses for Medicare Beneficiaries Hospitalized with Dehydration**

| Diagnosis Category                         | ICD-9-CM Code(s)   |
|--|--|
| Dehydration                                | 276.5  |
| Respiratory illness                        |  |
| Acute bronchitis                           | 466.0-466.1  |
| Chronic lung disease                       | 490.0-496  |
| Pneumonia and influenza                    | 480-487.8  |
| Gastroenteritis                            | 003.0, 008.5, 008.6,<br>008.8, 009.0-009.3,<br>536.2, 558.9, 787.0 |
| Other gastrointestinal conditions          |  |
| Abdominal pain                             | 789.0  |
| Cholelithiasis                             | 574.0-574.51   |
| Diseases of the esophagus                  | 530.0-530.9  |
| Diverticulitis                             | 562.01, 562.03, 562.11, 562.13                                     |
| Diverticulosis                             | 562.00, 562.02, 562.10, 562.12                                     |
| Gastritis                                  | 535.0-535.6  |
| Gastrointestinal hemorrhage                | 578.0-578.9  |
| Idiopathic proctocolitis                   | 556  |
| Intestinal obstruction                     | 560.8-560.99   |
| Pancreatitis                               | 577.0-577.9  |
| Paralytic ileus                            | 560.1  |
| Regional enteritis                         | 555.0-555.9  |
| Urinary system infection                   |  |
| Kidney infection                           | 590.0-590.9  |
| Urinary tract infection                    | 595.0, 595.9, 599.0  |
| Cancer                                     | 140.0-208.9  |
| Sepsis                                     | 038.0-038.9  |
| Cardiac                                    |  |
| Acute myocardial infarction                | 410.0-410.92   |
| Angina                                     | 411.1  |
| Arrhythmias                                | 427.0-427.32, 427.6-427.9  |
| Congestive heart failure                   | 428.0-428.9  |
| Frailty                                    |  |
| Aspiration pneumonia                       | 507.0  |
| Decubitus ulcer                            | 707.0  |
| Dementia                                   | 290.0-290.9, 331.0, 331.2, 797                                     |
| Impaction                                  | 560.3-560.39   |
| Malnourishment                             | 263.0-263.9, 262, 783.0, 799.4,<br>260, 261                        |
| Diabetes                                   | 250.0-250.91   |
| Other metabolic disorders                  |  |
| Diabetes insipidus                         | 253.5, 588.1   |
| Hyperkalemia                               | 276.7  |
| Hypernatremia                              | 276.0  |
| Hypoglycemia                               | 251.2  |
| Hypokalemia                                | 276.8  |
| Hyponatremia                               | 276.1  |
| Hypotension                                | 458.0-458.9  |
| Inappropriate antidiuretic hormone (SIADH) | 253.6  |