Original Article

Dehydration as referral diagnosis to a medical admittance department

Anja Poulsen & Frank Vinholt Schiødt

Digestive Disease Center K, Bispebjerg Hospital, Denmark

ABSTRACT

INTRODUCTION: Patients are frequently admitted to hospital on suspicion of dehydration. The diagnosis is widely used for referral to admittance departments. We aimed to prospectively evaluate patients admitted with a diagnosis of dehydration in terms of the accuracy of this diagnosis, to evaluate clinical and biochemical data and to evaluate the outcome and provide a review of the concept of dehydration.

METHODS: Patients who had dehydration as their primary referral diagnosis were prospectively included over a 70-day period. We defined dehydration based on osmolality > 295 mmol/kg. Biochemistry, imaging and outcome were examined.

RESULTS: A total of 128 patients were admitted on suspicion of dehydration, accounting for 7.5% of all patients admitted. In all, 82 of the 128 (64%) were dehydrated. The diagnoses at discharge included infections mainly, but also diagnoses such as cancers and stroke were registered. Mortality during hospitalisation was 9%. Mortality at six months was 27% for the entire group; 37% in the dehydration group versus 11% in the non-dehydration group (p = 0.002). Older age was the strongest predictor of death.

CONCLUSIONS: Suspicion of dehydration is a frequent admittance diagnosis. We suspect that a referral diagnosis of dehydration often reflects an unspecified concern rather than a real suspicion of dehydration. Patients with dehydration had a high in-hospital and six-month mortality, reflecting the severity of this diagnosis.

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Patients are frequently admitted to hospital on suspicion of dehydration. These patients are often elderly who have nonspecific symptoms and a wide range of co-morbidities [1]. The diagnosis of dehydration is widely used and often based on individual clinical assessment. However, no clear definition of dehydration exists in the literature [2-14]. Elderly patients tend to have more complex issues and more blurry symptoms than other patients, possibly making this group of patients more vulnerable and more difficult to diagnose [2]. We aimed to prospectively evaluate patients admitted with a diagnosis of dehydration in terms of the accuracy of this diagnosis, to evaluate clinical and biochemical data and to evaluate outcome. Furthermore, we aimed to discuss the difficulties and pitfalls in detection of dehydration.

Patients with dehydration are generally elderly people with co-morbidity
(*Toke Schultze* - Founthouse).

METHODS

The study was approved by the Danish Data Protection Agency, R. no. 05380, BFH-2017-029. The Danish Data Protection Agency is an independent authority that supervises compliance with the rules on protection of personal data.

Prospectively, over a 70-day period from 1 February to 11 April, 2017, we recorded data on consecutive patients referred to the General Medical Admittance Department (GMA), Bispebjerg Hospital, Denmark (a secondary urban referral hospital) with a main (A) diagnosis of dehydration. GMA covers endocrinology, gastroenterology, pulmonology and geriatrics. Patients were referred from their general practitioner or from the Emergency Medical Service (in Copenhagen known simply as "1813"). Bispebjerg Hospital is situated in a part of Copenhagen characterised by a low socioeconomic status. The study was observational.

Definition of dehydration: We defined dehydration as a plasma osmolality > 295 mmol/kg [3-14].

The following formula was used to calculate osmolality:

Osmolality = 2 × (plasma sodium concentration) + plasma glucose concentration + plasma urea nitrogen concentration [11].

Patient records were reviewed. Gender, age, admission time and the diagnoses at admission and discharge were recorded. Biochemistry, calculated osmolality based on plasma sodium, glucose and blood urea nitrogen and the objective description of hydration were recorded.
Data on ultrasonography and CT of the kidneys and urinary tract to eliminate possible differential diagnoses for an impact of creatinine and urea nitrogen levels were recorded.

A Cox regression analysis on survival was planned, including the following predefined parameters: gender, age, number of admission days, sodium, infections and dehydration [2, 3, 8].

Data are given as median (range) or number (percentage), where appropriate. We used the Mann-Whitney U-test and Fisher's exact test, where appropriate. Risk estimates for mortality were assessed for in-hospital stay and at

six months after admission using the Cox regression model. Log-rank test was used to compare survival curves.

Trial registration: The Danish Data Protection Agency, R. no. 05380, BFH-2017-029.

RESULTS

In the inclusion period, 1,727 patients were admitted to the GMA Department, median age 71 years (range: 16-105 years). A total of 128 patients (7.5% of those admitted) were admitted on suspicion of dehydration (80 women and 48 men). The median age of these patients was 81 years (range: 22-104 years). Eighty-two patients (64%) (53 women and 29 men) had dehydration according to the definition. **Table 1** compares patients with dehydration to those without for patients admitted on suspicion of dehydration. The dehydrated group had significantly higher levels of sodium, potassium, glucose, creatinine and urea. Also, these patients were older than the non-dehydrated patients.

TABLE 1 / Patients admitted with a suspicion of dehydration: comparison of patients with dehydration versus those without dehydration. Biochemical variables are values on admission.

	Dehydration (N = 82)	No dehydration (N = 46)	p-value[a]
Female/male, n	53/29	27/19	0.63
Age, yrs, median (range)	83 (22-104)	71 (27-98)	0.006
Admission time, days, median (range)	5 (0-41)	4 (1-41)	0.57
Plasma Na^+ concentration, mmol/l, median (range)	140 (127-168)	135 (120-142)	< 0.001
Plasma Na^+ concentration < 137 mmol/l, n (%)	11 (13.4)	30 (65.2)	< 0.001
Plasma K^+ concentration, mmol/l, median (range)	4.0 (2.4-7.1)	3.7 (2.6-5.0)	0.005
Plasma glucose concentration, mmol/l, median (range)	7.0 (3.8-19.9)	6.1 (3.8-10.9)	0.009
Plasma creatinine concentration, µmol/l, median (range)	98 (38-523)	81 (42-190)	0.004
Plasma urea nitrogen concentration, mmol/l, median (range)	9.4 (1.0-55.8)	4.3 (1.2-16.6)	< 0.001
Plasma osmolality, mmol/kg, median (range)	305 (296-353)	288 (251-294)	< 0.001
Objective signs recorded in medical journal, n (%)	14 (17.1)	4 (8.7)	0.22
US/CT of urinary tract performed, n (%)	23 (28)	12 (26.1)	0.98
In-hospital mortality, n (%)	10 (12.2)	1 (2.2)	0.10
Mortality at 6 mo.s, n (%)	30 (36.6)	5 (10.9)	0.002

US = ultrasonography.
a) Mann-Whitney U-test and Fisher's exact test, where appropriate.

Diagnoses at discharge in the dehydrated group were as follows: dehydration only (n = 8), infections (n = 76, hereof: urinary tract infections; n = 24, pneumonia; n = 20, gastroenteritis: n = 19), gastrointestinal diagnoses (n = 27; acute abdomen, liver cirrhosis, gastric ulcer, oesophageal candidiasis, chronic pancreatitis, constipation),

psychiatric diagnoses (n = 12), cancers (n = 9; four known and five newly discovered), heart disease (n = 4, decompensation and arrhythmia), newly diagnosed strokes (n = 6), other diagnoses (n = 35).

Sodium: In the non-dehydrated subgroup, 65% of the patients had hyponatremia (plasma sodium concentration < 137 mmol/l) compared with 11% in the dehydrated subgroup (Table 1).

Radiology: A total of 35 patients underwent imaging of the kidneys and urinary tract; the distribution was equal in the two groups (Table 1). One patient was diagnosed with parenchymal kidney disease, two patients had hydronephrosis.

Objective clinical signs: Eighteen (14%) patients' medical records had mentioning of their clinical hydration level. Among these, 14 were dehydrated and four were not. Three patients in the group described as objectively clinically dehydrated lacked the biochemical signs. Two patients were described objectively as not dehydrated, one of whom was biochemically dehydrated (Table 1).

Mortality: The total in-hospital mortality for all patients admitted to the GMA department in the study period was 2% (38/1,727 patients). The in-hospital mortality for patients admitted on suspicion of dehydration was 9% (11 patients). Ten of these 11 patients were from the dehydrated group (Table 1). The causes of death during hospital stay included: infections (n = 6), disseminated cancer (n = 2), ischaemic stroke (n = 2) and dehydration combined with old age (n = 1). Mortality at six months after admission was 27% (35 patients), which was significantly higher in the dehydrated group (Table 1).

Figure 1 shows the survival curves for the dehydrated versus the non-dehydrated group (log-rank test; p = 0.005).

FIGURE 1 / Cumulative survival probability for patients admitted on suspicion of dehydration. Comparison of patients with dehydration (- - -) versus patients without dehydration (—). Log-rank test, p = 0.005.
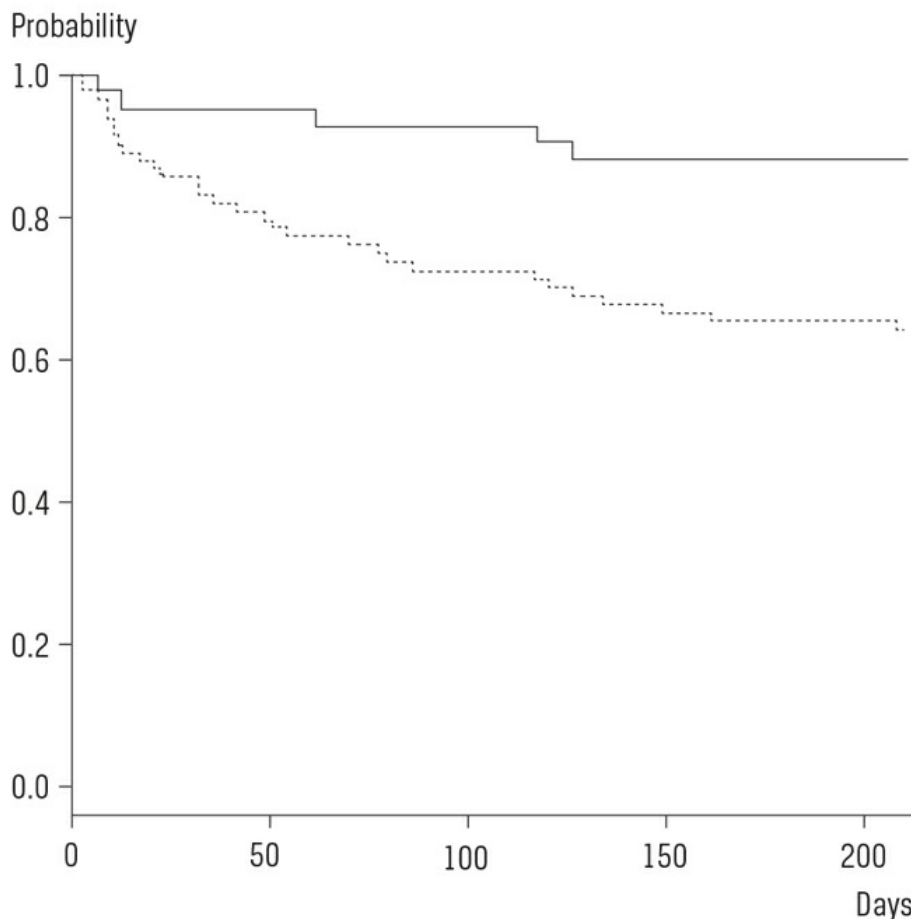
A Cox regression analysis was performed, including gender, age, number of admission days, sodium, infections and dehydration. These parameters were chosen before the study period: older age was the most important predictor for death (p = 0.006), whereas the other variables did not reach significance (p = 0.14 for dehydration).

DISCUSSION

In our study, more than 7% of all patients admitted to the GMA department were admitted on suspicion of dehydration. This is comparable to a study from 1991 in which 6.7% of Medicare hospitalisations were patients admitted with dehydration [2]. We found that approximately two thirds of patients admitted on suspicion of dehydration were in fact dehydrated according to the definition used. Many patients admitted on suspicion of dehydration ended up having many other main (A) diagnoses, and we suspect the dehydration admittance diagnosis may have been used to gain 'entry' to the hospital because of a suspicion of severe nonspecific sickness.

To our surprise, documentation of clinical signs of hydration/dehydration were only recorded in the medical

records in 14% of patients admitted on suspicion of dehydration. There may be some under-documentation, but we still emphasise the need to document these important signs including dry tongue, oral membranes, tongue furrows, dry arm pits, decreased skin turgor, sunken eyes and delayed capillary refill time [1, 6, 7].

Plasma levels of creatinine and urea were significantly higher for patients with dehydration than for those with no dehydration. However, levels overlap between the groups and creatinine and urea levels cannot stand alone in the assessment of dehydration.

Our study demonstrates a significant mortality related to a hospital referral with a diagnosis of suspected dehydration. In fact, the six-month mortality rate reached 27%, which is comparable to another study, in which 30-day and 31-365-day mortality was 17.4% and 30.6%, respectively [2]. Other studies have indicated an excess mortality in patients diagnosed with dehydration compared with the general patient population [3]. In our study, the mortality rate was affected by a study population containing dehydrated patients of all ages (22-104 years). What characterised the dehydrated group compared with the non-dehydrated group was that they were older and had an increased mortality rate. The high in-hospital mortality in the dehydration group was caused primarily by infections, but we could not assess the cause of death in those who died after discharge. Our Cox regression analysis showed that old age was the only significant factor for mortality, with the predefined parameters included. This suggests that dehydration in itself may not necessarily be fatal, but may be a sign of weakening of the old patient. Since risk factors such as limited mobility and even functional disabilities are more frequent in old age, elderly patients are more likely to need assistance with food and fluid intake, incontinence (which limits fluid intake), co-morbidities, number of medications, acute infections and depression [1, 3, 4, 12, 13, 15-17].

We chose a definition of dehydration that included calculated osmolality as used in other studies [3-14]. However, other used definitions for dehydration are many, including urea/creatinine ratio ≥ 20, ultrasonic vena cava diameter, low blood pressure, objective clinical findings, weight loss, urine, saliva, tear and sweat osmolality [1, 3, 5-7, 9, 12-14]. Urine markers such as urine osmolality and colour are less useful in elderly people, since urine colour can be affected by other factors including medications and diet; and the urine osmolality mechanism is not as tightly regulated in elderly as in young people [13, 15]. Other biochemical measures for dehydration include displacement of electrolytes, especially serum sodium, which is seen more often in dehydrated than non-dehydrated individuals [1, 3, 5, 6, 8, 9, 13, 16], as we also observed in our study.

CONCLUSIONS

Our study showed that suspicion of dehydration is a frequent cause of admittance to a medical department. This admittance diagnosis is true for two thirds of the patients but many patients end up having more serious final diagnoses, and we suspect this admittance diagnosis may have been used to gain entry to hospital for patients with nonspecific symptoms. Clinical signs of hydration are often not documented in the medical records. In-hospital and six-month mortality are high for patients admitted on a suspicion of dehydration, the most important factor determining mortality is older age. We suggest a thorough search for co-morbidity in all patients admitted on suspicion of dehydration.

CORRESPONDENCE: *Anja Poulsen*. E-mail: anjapoulsen@live.dk

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