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Research paper

Dehydration and clinical outcome in hospitalised older adults: A cohort study



A.M. El-Sharkawy^a, A. Virdee^a, A. Wahab^a, D.J. Humes^{a,b}, O. Sahota^c,
 M.A.J. Devonald^d, D.N. Lobo^{a,*}

^a Gastrointestinal surgery, National institute for health research Nottingham digestive diseases biomedical research unit, Nottingham university hospitals and university of Nottingham, Queen's medical centre, Nottingham NG7 2UH, UK

^b Division of epidemiology and public health, university of Nottingham, Nottingham NG7 2UH, UK

^c Department of elderly medicine, Nottingham university hospitals, Queen's medical centre, Nottingham NG7 2UH, UK

^d Department of renal medicine, Nottingham university hospitals, City hospital campus, Nottingham NG5 1PB, UK

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ABSTRACT

Background: Older adults are susceptible to dehydration due to age-related changes. This study aimed to investigate the prevalence of clinically diagnosed dehydration in older adult medical emergency hospital admissions and assess the impact on length of hospital stay (LOS) and mortality.

Methods: Data were retrieved from the hospital's electronic database relating to all emergency admissions of patients aged ≥ 65 years between 1 April 2011 and 31 October 2013. The Charlson comorbidity index, LOS and mortality were calculated.

Results: Of the 42,553 patients identified, 32,980 (77.5%) were admitted to medical specialties. Dehydration was noted in 2,932 (8.9%) patients and was the primary cause of admission in 190 (0.6%). The prevalence of dehydration also increased with age and comorbidity. Acute kidney injury was reported in 47.7% of patients with dehydration, compared with 15.9% of patients without dehydration, $P < 0.001$. The median (interquartile range) LOS in patients diagnosed with dehydration was 8 (4–19) days compared with 3 (1–8) days in those without dehydration, $P < 0.001$. Patients admitted with a primary diagnosis of dehydration had a 17% 30-day mortality and 44% one-year mortality compared with 7% and 25% respectively in patients without dehydration, $P < 0.001$. Patients diagnosed with dehydration during hospitalisation were twice more likely to die in hospital, HR 2.11 (95% CI 1.92–2.32), $P < 0.001$, independent of age, gender and comorbidities.

Conclusion: A small but significant proportion of hospitalised older adults was diagnosed with dehydration, which was associated with an increase in LOS and mortality, independent of age, gender and comorbidities.

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1. Introduction

Maintenance of fluid and electrolyte balance is essential to normal physiological function and older adults are susceptible to fluid and electrolyte imbalance due to numerous age-related factors [1]. There is a reduction in lean body mass accompanied with a reduction in total body water by 10–15%, as well as a blunted thirst response and a reduction in renal function by up to 63% from the age of 30 to 80 years [1].

These age-related changes often result in a hyperosmolar state, which can lead to alterations in cell metabolism and

function, mediated by changes in cell volume [2]. Serum hyperosmolality has also been associated with poor outcome in patients admitted to hospital with stroke and critical illness, and those with acute coronary syndrome receiving percutaneous coronary intervention [3–6]. Other studies have reported an association between acute and chronic dehydration and several other conditions [6].

A pilot study investigating dehydration at admission in 200 older adults reported that hyperosmolar dehydration (serum osmolality > 300 mOsm/kg) was associated a 6-fold increase in hospital mortality HR 6.04 (95% CI 1.64–22.25, $P = 0.007$), independent of age, gender, comorbidities and illness severity [7].

The present study aimed to estimate the prevalence of clinically diagnosed dehydration during hospitalisation and to compare the

* Corresponding author. Tel.: +44 115 8231149; fax: +44 115 8231160.
 E-mail address: Dileep.Lobo@nottingham.ac.uk (D.N. Lobo).

impact of this condition on length of hospital stay (LOS) and mortality in older adult medical emergency hospital admissions.

2. Methods

This retrospective cohort study in older adult patients (aged ≥ 65 years) was conducted using data collected from a large university teaching hospital NHS Trust in the UK. The standardised mortality rate for the Trust was in keeping with the national average and the Trust was described as safe, caring, effective and well-led by the Care Quality Commission [8,9], which also noted evidence in the acute setting “that staff assessed nutrition and hydration needs and that they put in place and followed care plans if specific needs were identified, for example, if a patient required assistance at meal times” [9].

The database was searched by a specialist data analyst who retrieved data that related to patients aged ≥ 65 admitted to medical specialties as an emergency between the 1 April 2011 and 31 October 2013. The Trust changed the way dehydration was coded in March 2011 to comply with national guidelines defining dehydration coding and the study start date was chosen to ensure constancy. Each record represented an individual admission and contained patient identifiers, demographics and contained up to 25 diagnoses related to the admission and comorbidities classified according to the International Classification of Disease (ICD-10) [10]. In addition, it also contained details of the dates of death for patients regardless of whether they had died in hospital or in the community up to 29 December 2014. Using these data, LOS, in-hospital-, 30-, 90- and 365-day (one-year) post-admission mortality were calculated.

2.1. Covariates

Covariates such as gender were obtained from the hospitals database. Other variables were calculated using the information retrieved. Age at admission was calculated using date of birth and date of admission and then categorised into four time periods each, 65 to 75, 76 to 85, 86 to 95 and > 95 years.

To account for comorbidities the Charlson Comorbidity Index (CCI) score was calculated for all records [11] and adapted to the ICD-10 coding system [12]. CCI was calculated to include all the recorded diagnoses including the primary cause of admission which were coded after discharged from hospital or death.

2.2. Study outcome

The primary objective of this study was to measure the prevalence of clinically diagnosed dehydration during hospital admission in older adults. In this study, the diagnosis of dehydration (ICD-10 E86.X) was recorded by the hospital's coders where hospital clinicians diagnosed patients to be in a state of severe dehydration or dehydration treated with IV solutions and excludes other diagnoses of hypovolaemia consistent with national coding protocols [10]. All patients with dehydration were identified and if any patient was admitted multiple times over the study period their first admission was selected.

Secondary outcomes were the effects of clinically diagnosed dehydration on mortality and LOS. Date of death was retrieved from the hospital database and this was used to identify patients who had died, as well as time to death. LOS was calculated using dates of hospital admission and discharge was also retrieved from the hospital database. Patients who died in hospital were excluded from the LOS analysis.

Dehydration has been linked with acute kidney injury (AKI) and has been identified as a potentially avoidable cause of AKI [13]

Diagnosis and stage of AKI were retrieved from the hospitals AKI electronic-alert database [14]. These data were linked using the patient's unique hospital number and date of admission. Details of the algorithm used for the alert have been published previously [14].

2.3. Subgroup analysis

The principal diagnoses corresponding to each admission were grouped into disease categories according to ICD-10 chapters to allow for sub-group analysis of conditions that commonly cause hospital admission in older adults, including cardiovascular, respiratory and gastrointestinal conditions. Covariates calculated above were used in this analysis. However, the CCI did not include the primary cause hospital admission for this analysis.

2.4. Statistical analysis

Data analysis was performed using Stata Statistical Software Release 13 (StataCorp LP, College Station, TX). Normally distributed data were presented as means and standard deviations (SD) and the independent samples *t*-test was used to assess for statistically significant differences. Non-parametric data were presented as medians and interquartile ranges (Q1–Q3) and the Kruskal Wallis test was used to assess for statistically significant differences. Chi-squared analysis was used to assess for statistically significant differences between categorical variables and Kaplan-Meier survival plots were generated to represent schematically one year survival stratified by hydration status. Cox regression modelling was used to determine unadjusted and adjusted hazard ratios (HR) as an approximation of risk of mortality in the presence of dehydration. Adjustments were made for potential confounding factors including age, gender and comorbidity (CCI). In this study age-unadjusted CCI scores were used in the Cox analysis, with age categories investigated separately in keeping with the validated method developed by Charlson [11].

2.5. Data validation

The hospital's database is updated and crosschecked with the National Summary Care Record system by the Data Quality team on a daily basis to ensure accuracy. Primary and secondary diagnoses relating to each admission are coded in accordance with the ICD-10 classification and uploaded onto the hospital database once patients are discharged from hospital or deceased. Regular internal audits are undertaken by a Health and Social Care Information Centre (HSCIC) accredited auditor to ensure quality control and external audits were undertaken by Caspe Healthcare Knowledge Systems (CHKS) (<http://www.chks.co.uk>) and overseen by Monitor (<https://www.gov.uk/government/organisations/monitor>). Both audits reported that the coding for the primary and secondary diagnoses were 96% and 93–95% accurate, respectively.

The study team audited the accuracy and appropriateness of the clinical diagnosis of dehydration by reviewing a randomly selected sample of 200 written and electronic notes.

Further validation of a larger cohort was carried out using the serum biochemistry measured during the admission. Osmolality is widely accepted as one of the most accurate markers of hydration, however, this is measured rarely. Osmolarity calculated using the equation described by Krah and Khajuria [15] has been shown to be up to 97% sensitive and 76% specific at diagnosing dehydration in older adults [16].

Serum osmolarity = $1.86 \times ([Na^+] + [K^+]) + (1.15 \times [glucose]) + [urea] + 14$

where serum osmolarity is in mOsm/l and concentrations of Na^+ , K^+ , glucose and urea are in mmol/l.

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