OPEN ACCESS
Freely Available Online

JOURNAL OF AGEING RESEARCH AND HEALTHCARE
ISSN NO: 2474-7785

Short Communication
DOI : 10.14302/issn.2474-7785.jarh-17-1420

Can poor hydration amongst older hospitalized people be identified by single point total body water assessment ? – a pilot study

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Abstract

Dehydration in acute care is associated with increased morbidity and mortality. However, no standard approach to hydration assessment exists in clinical settings. The pilot study aimed to explore total body water content as means for immediately assessing hydration status in clinical settings. People aged 60 years or more, voluntarily admitted to a tertiary teaching hospital's Geriatric and Rehabilitation Unit were eligible for participation. Total body water assessment by tracer dilution was compared with standard clinical assessment of hydration status. The study participants (78.6±8.5 years, 6/14, 43% male) clinically assessed with poor hydration (3/14) had a higher percentage of body weight as water (59.0±2.3 vs 50.6±6.4%), and lower mean weight (54.1±12.9 vs 77.5±24.1 kg) and lower body mass index (20.0±3.7 vs 30.2±6.5 kg/m2) than the well-hydrated (11/14). Weight (n=14) and body mass index (n=11) explained a substantial proportion of variation in total litres of body weight as water (r=0.92, R^2=0.85; r=0.80, R^2= 0.64) and percentage of body weight at water (r=0.6, R^2= 0.36; r=0.72, R^2= 0.52) respectively. This pilot study revealed higher percentages of body weight as water amongst those clinically assessed with poorer hydration. Future regression analysis of total body water and hydration needs to adjust for the potential confounding effect of weight and body mass index. Implications for practice from this preliminary study indicate that findings did not support single point measurements of either total body water or percentage of body weight as water as potentially simple methods for clinically assessing hydration status amongst older hospitalised people.

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Citation: Angela Vivanti (2017) Can Poor Hydration Amongst Older Hospitalized People be Identified by Single Point Total Body Water Assessment? – A Pilot Study. Journal of Aging Research And Healthcare - 1(3):28-32. https://doi.org/10.14302/issn.2474-7785.jarh-17-1420

Running Head: Can poor hydration be assessed by single total body water measure?

Keywords: Dehydration; hypovolemia; elderly; clinical; assessment; hospital

Received Jan 03, 2017; **Accepted** Feb 13, 2017; **Published** Mar 06, 2017;

Academic Editor: Ian James Martins, Edith Cowan University

Introduction

Poor hydration is associated with increased morbidity and mortality during acute hospital care and in long stay care units[1,2,3]. Simple tools such as bioelectrical impedance analysis (BIA) are an inexpensive method to assess total body water in clinical practice, but the use of total body water measures as a valid assessment of hydration status has not been established.

To explore the potential value of measuring total body water as a means to assess the hydration status of older people in a clinical setting, this pilot study investigated clinical hydration assessments against total body water status as evaluated by gold standard tracer dilution.

Method

Participants were recruited as a cohort to a larger study of older people aged 60 years or more admitted to a publicly-funded tertiary referral teaching hospital. Of 82 consecutive new admissions approached, 18 were not eligible for participation and 21 declined participation (10 fully declined and 11 agreed to study access to chart information only). Of the resulting 43 participants (7 with clinically assessed dehydration), 14 participated in the dilution study component. A single medical officer performed the hydration assessment of all participants based upon: fluid intake, urine output, weight changes, surgical history, medical history, and physical examination as previously described[4]. Good inter-rater reliability and validity of the hydration assessment was established in the clinical setting[4].

Total body water was assessed using tritium dilution methods as previously described[5, 6]. Clinically assessed hydration status was compared against total body water (percentage and litres) with parametric data presented as means and standard deviations. Homogeneity of variance was confirmed and the proportion-of-variation (R^2) explained by weight and body mass index against body water composition (percentage and litres of total body water, litres of extracellular water and percentage of total body water as extracellular water) were completed.

Results

The participant group (78.6±8.5 years; 6/14, 43% male) were representative of the Geriatric and Rehabilitation Unit populations' age and gender. Neither age nor gender were associated with poor (78.0±7.8 years; 33% male) or well-hydrated (78.8±9.0 years; 45% male) participants. Serum osmolality was not clinically different between the poor and well hydrated groups (Table1).

Table 1: Comparison of the percentage and litres of body weight as water (assessed by tritium dilution), weight and body mass index with clinically assessed hydration status.

	Good hydration (n=11) Mean±sd	Poor hydration (n=3) Mean±sd	Mean difference [95% CI]
Serum Osmolality mmol/kg	272.4±7.5	275.3±13.9	
% total body water (tritium dilution)	50.6±6.4	59.0±2.3	8.4 [-0.01 to 16.8]
Litres of total body water (tritium dilution)	38.5±9.4	31.9±7.7	-6.6 [-19.6 to 6.5]
Weight (kg)	77.3±24.1	54.1±12.9	-23.4 [-55.4 to 8.7]
Body mass index (kg/m2)	30.2±6.5 (n=8)	20.0±3.7	-10.2 [-19.4 to 9.5]

Wide individual variation in total body water content (42%-67%) was evident. When clinically

assessed as poorly or well hydrated, clinically significant differences were evident in the weight, litres and percentage of total body weight as water assessed by dilution (Table 1). Paradoxically, those clinically assessed with poor hydration showed a clinically significant greater percentage of total body weight as water as assessed by dilution (mean difference 8.46%) (Table 1).

Compared with the well-hydrated, weight was substantially lower if clinically assessed with poor hydration (Table 1). Weight explained a substantial proportion of variation in the litres of body weight as water (r=0.92, R^2= 0.85, n=14). A slightly lower proportion of variation in the percentage of body weight at water was explained by weight (r=0.6, R^2= 0.36, n=14).

Due to the difficulty of obtaining height, body mass index was available for all poorly hydrated and 8 of the 11 well-hydrated participants. Body mass index was higher for those assessed as well-hydrated compared with poorly hydrated and explained a substantial proportion of variation in the total litres (r=0.80, R^2= 0.64, n=11) and percentage (r=0.72, R^2= 0.52, n=11) of body weight as water.

Discussion

Although clinical assessment indicated poorer hydration, participants were not confirmed with full dehydration as indicated by serum osmolality[7, 8]. During fluid deficit, animal studies have shown preferential retention of plasma proteins, increasing plasma colloid osmotic pressure and preserving plasma volume by enhancing fluid retention within the vasculature[9, 10]. Preferential fluid loss from certain organs such as muscle, skin and gut has also been shown by other animal studies[11, 12]. Such animal studies provide insights into the value of elevated serum osmolality as an endpoint market for dehydration, but may highlight limitations for its usefulness throughout the whole process of increasing fluid deficit.

This pilot study revealed, potentially counter-intuitively, that participants clinically assessed with poorer hydration had a higher percentage of body weight as water. However, mean body weight and body mass index were lower when clinically assessed as poorly hydrated. With increased body mass index, the percentage of total body water decreased. As excess weight is gained, proportionally more adipose tissue (which contains a lower water content compared with lean tissue) is acquired[13]. Composition of body weight may reconcile why the poorly hydrated participants (whose mean weights and body mass index's were lower) demonstrated higher percentages of body weight as water compared with their well-hydrated counterparts (whose mean body weights, body mass index's and thus potentially adipose tissue were higher).

This poor concordance was found in another study comparing clinically assessed hydration status with bioelectrical impedance presented as percentiles[14]. Hyper-hydration was indicated amongst the patients clinically judged with poor hydration however, no weight data was presented by the authors[14] to assess if body weights were lower amongst the poorly hydrated.

Anecdotally, colleagues from several professional disciplines have expressed their interest in BIA, anticipating it could provide a simple means to assess hydration in the clinical setting. Within-person reproducibility for impedance measurements of less than 5% has been confirmed in both younger and older populations[15, 16, 17]. However, the viability of one-off total body water measures, such as by using portable bioelectrical impedance technology, as a means of

identifying poor hydration status on an individual basis including within clinical settings may be questioned when considering hypo-hydration indicated by 1-4% loss of body weight as water[18,19, 20, 21, 22] and the wide variations evident in this study of individuals total body water content (42%-67%).

Future regression analysis of total body water and hydration needs to adjust for the potential confounding effect of weight and body mass index. The study sample size was small, but sufficiently highlights concerns, difficulties and practical limitations in the proposal to use one-off measures of total body water content for the assessment of hydration amongst older people in hospital. Consequently, short term weight change remains the most accepted means for confirming hydration status changes[23, 24].

Acknowledgements

Acknowledgements and thanks are extended to Mike Roberts, Sue Ash, Leigh Ward, Keren Harvey, Steven Mason, Sheree Cross, Paul Masci, Gareth Winckle, Diana Battistutta and the Beau Martin Trust Fund for their support during the completion of this study.

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