M-1800(R)

Developing a quick and practical screen to improve the identification of poor hydration in geriatric and rehabilitative care

Angela Vivanti[a,d,*], Keren Harvey[b], Susan Ash[c,d]

[a]Nutrition and Dietetics, Princess Alexandra Hospital Health, Ipswich Rd, Woolloongabba, Qld 4103, Brisbane, Australia

[b]Department of Geriatric Medicine, The Prince Charles Hospital, Rode Road, Chermside, Brisbane, 4032, Australia

[c]School of Public Health, Queensland University of Technology, Victoria Park Road, Kelvin Grove, Brisbane, 4059, Australia

[d]Institute of Health and Biomedical Innovation, Queensland University of Technology, 60 Musk Avenue, Kelvin Grove, Brisbane, 4059, Australia

*Corresponding author:
Phone: + (61-7)-3240-5099
Fax: + (61-7)-3240-5959
E-mail: angela_vivanti@health.qld.gov.au

Abstract

Dehydration has been associated with increased morbidity and mortality. Dehydration risk increases with advancing age, and will progressively become an issue as the aging population increases. Worldwide, those aged 60 years and over are the fastest growing segment of the population. The study aimed to develop a clinically practical means to identify dehydration amongst older people in the clinical care setting. Older people aged 60 years or over admitted to the Geriatric and Rehabilitation Unit (GARU) of two tertiary teaching hospitals were eligible for participation in the study. Ninety potential screening questions and 38 clinical parameters were initially tested on a single sample (n=33) with the most promising 11 parameters selected to undergo further testing in an independent group (n=86). Of the almost 130 variables explored, tongue dryness was most strongly associated with poor hydration status, demonstrating 64% sensitivity and 62% specificity within the study participants. The result was not confounded by age, gender or body mass index. With minimal training, inter-rater repeatability was over 90%. This study identified tongue dryness as a potentially practical tool to identify dehydration risk amongst older people in the clinical care setting. Further studies to validate the potential screen in larger and varied populations of older people are required.

Keywords: Dehydration screening of elderly patients; Dehydration screening tool; Hospital dehydration; Geriatric rehabilitation; Adjusting for potential confounders

1. Introduction

The diagnosis of dehydration in clinical care has been associated with increased morbidity and mortality (Warren et al., 1994). Older people 85-99 years were reported to be six times more likely to be admitted to hospital with dehydration than those 65-69 years (n = 731 695) (Warren et al., 1994). Worldwide, those aged 60 years and over are the fastest growing segment of the population and those over 80 years are the fastest growing group (WHO, 2002). Not only is there an increasing proportion of older people in the population, the increasing number of the very old will place even greater demands on social and health services around the world.

Currently, dehydration in older people is under-recognized. Dehydration (assessed by elevated serum osmolality, sodium and urea/creatinine ratio) in older people during an admission (21% and 26%), (Bowker et al., 1992; Thomas et al.,

2003) was higher than the ICD-coded dehydration indicated from the chart (6.7%) (Warren et al., 1994). Not all people clinically assessed with dehydration show elevated biochemistry and consequently the use of elevated serum biochemistry has the potential to underestimate poor hydration if the individual is hypo- or iso-tonic (Weinberg and Minaker, 1995).

Colloquially, the term dehydration has been used synonymously with any loss of fluid (Mange et al., 1997). This colloquial usage of the term is reinforced by International Classification of Diseases (ICD-10-AM) code “E86”, a collective code for volume depletion or depletion of the volume of plasma or extracellular fluid or dehydration (National Centre for Classification in Health, 2002). In this study, the term dehydration will be used to encompass all forms of fluid deficit (volume depletion and dehydration).

The development of a practical dehydration screening method would help to identify older people at risk and prioritise resources for diagnosis and treatment (Wilson and Jungner, 1968). The only dehydration screening method identified in the literature assessed axillary moisture after 24 hours abstinence from antiperspirant use in older people admitted for acute medical conditions (Eaton et al., 1994). The screen's sensitivity was 50%, positive predictive value was 45% and the inter-rater reproducibility was 80%. Further exploration of a clinically more sensitive and useful dehydration screening method is warranted. Consequently, the aim of this study was to develop a simple, sensitive dehydration screening method for use with older people in the clinical care setting.

2. Methods

The study was undertaken in 3 Phases as outlined in Figure 1. Phase 1 collected, assessed and identified the potential of a large number of potential screening parameters (questions and clinical parameters) to distinguish hydration status (Vivanti et al., 2008). Phase 2 assessed a reduced number of the most promising parameters with a greater number of participants. Phase 3 assessed the inter-rater and intra-rater reliability of the parameter most strongly associated with clinically assessed dehydration.

2.1. Study population, frame and representativeness

Older people aged 60 years or over admitted to the Geriatric and Rehabilitation Unit (GARU) of two metropolitan hospitals were eligible for this study. The GARU’s of

a 750 bed (Phase 1 and 2) and 450 bed (Phase 2 and 3) publicly-funded tertiary referral teaching hospitals in a subtropical climate participated.

Ethics approval and signed informed consent were obtained prior to study data collection. During Phase 1, individuals were excluded if: involuntarily admitted, informed consent was not obtained, were younger than 60 years or fitted with a pacemaker, due to a contraindication for another concurrently-running study component. During Phases 2 and 3, pacemaker exclusion was not required.

The age and gender of the participants and those admitted to the GARU wards were compared with the older hospital population in order to assess the representative nature of study participants.

2.2. Phase 1: Screening tool survey construction and design

Phase 1a of the study results were previously published (Vivanti et al., 2008), and identified the most promising clinical assessment parameters associated with dehydration. The drop in systolic blood pressure of 20 mmHg or more on standing, poor skin turgor (two or more seconds), low body mass index (BMI less than 20) and presence of a dry tongue (yes or no) were included for assessment as potential dehydration screening methods.

Phase 1b screening questions for testing were developed from a combination of parameters highlighted through published literature, published opinion and professional opinion by interview. Response categories were piloted with “always, often, sometimes, never” being preferred to “not at all, a little, quite a bit, very much”. Developed questions were piloted to assess suitability, ease of use, understanding and selection of categorical wording. Phase 1b investigated a wide range of potential screening questions to enable the identification of the most promising potential screening parameters

2.3. Phase 1: Selection of potential dehydration screening questions for further testing

Questions were deleted from further investigation during Phase 2 if patients found them difficult to answer during Phase 1b. Parameters with a high response rate and crude odd ratios of four or more indicated the most clear distinction between the responses provided by the dehydrated and well-hydrated groups. Due to the natural tendency to respond dichotomously, questions were rephrased enabling “always,

often or sometimes” to respond “yes" while “never” was changed to “no” prior to Phase 2 testing. Two questions were also rephrased in a minor way from "How often did..." to "Did..." to accommodate the yes/no response during Phase 2.

2.4. Phase 2: Study design and recruitment

Phase 2 investigated the reduced number of parameters with a higher number of study participants. During Phase 2, each site had one consultant of geriatric medicine completing clinical dehydration assessments and one senior nursing staff member completing potential screening parameters. One author (AV) assessed weight. Results from each remained blinded to the other participating staff members. During data collection, staff met the consented participant within minutes of each other.

During Phase 2, participants at greater perceived dehydration risk were selected to maximise the outcomes from testing of parameters for the number of participants recruited. Those identified by the wards' Nurse Practice Consultant to be eating and drinking well with no perceived risk of dehydration were not approached.

2.5. Clinical validation

Identified parameters were tested individually against the global clinical assessment of dehydration (categorized as nil, mild, moderate, or severe by consultants in geriatric medicine) based upon individual professional judgment which included medical and surgical history, physical examination, fluid intake, urine output and weight changes. The person completing study data analysis was independent of the clinical dehydration assessments. The judgment of clinical dehydration assessment was previously verified in the clinical setting against short-term weight change and inter-rated reliability (Vivanti et al., 2008).

2.6. Repeatability

During Phase 1, all initial screening data collection was completed by one person, eliminating inter-rater variability. High agreement (87%, 20/23, Kappa 0.7) was confirmed in the clinical dehydration assessment between the two study consultants in geriatric medicine participating in Phase 2 (Vivanti et al., 2008).

During Phase 3, the percentage agreement and the kappa statistic described the inter- and intra-rater repeatability for the potential screen. Consented participants

were assessed independently by the two experienced nursing staff (involved in the initial study data collection) and one author (with no experience in dehydration assessments) on one day and between one nursing staff member and the study's consultant in geriatric medicine on another day (due to operational convenience). All results remained blinded from the other staff members. After the initial assessment, participants were asked not to consume any fluid until the second assessment. The second assessment was conducted within 10 minutes of the initial visit in a random order, mixing rooms and beds, in order to reduce the likelihood of recall.

To assess the influence of training on inter-rater reliability, the exercise was repeated on another day with one of the senior nursing staff, one author and one pharmacist, after brief training on the assessment of potential dehydration screening method by the study's consultant in geriatric medicine.

2.7. Data analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (Release 11, SPSS Inc, Chicago, IL, 2003). Descriptive statistics were generated for the age and gender characteristics of the study population and compared to the older hospital and GARU populations and those declining participation. Means and standard deviations summarized continuously-scaled variables (or medians and ranges where distributions were skewed), and categorical variables were summarized as counts and percentages.

The final screening parameters to undergo testing in Phase 2 were assessed individually against the clinical assessment of dehydration by consultants in geriatric medicine. Odds ratios, with corresponding 95% confidence intervals, described the association between clinically-assessed dehydration status and the parameters under investigation, were obtained through logistic regression analysis.

Subsequent to Phase 2 data collection, confounding effects from age by category (60-79 years, 80 years or over) (WHO, 2002), gender and BMI (less than 20, 20 and more) (English, 1987) upon the association between the parameters and dehydration status were assessed by linear regression if continuous variables and logistic regression if categorical variables. Confounding was judged as considerable if adjusted odds ratios differed from unadjusted estimates by more than 10%. Logistic regression using forward entry of variables was completed to adjust for the effects of the other parameters during model exploration.

3. Results

3.1. Representativeness of study participants

Gender (39/86, 45.3% male) and mean age (78.6 +/-8.3 years) of Phase 2 study participants were not clinically different from the final GARU discharges (Hospital 1: 456/963, 47.4% male, 77.2 +/-9.1 years; Hospital 2: 341/808, 42.2% male, 78.5+/-8.3 years) or the hospital population aged 60 years and over at either hospital (Hospital 1: 14 207/28 308, 50.2% male, 71.7 +/-7.8 years; Hospital 2: 6431/11 485, 56.0% male, 72.2+/-7.9 years). Those declining participation did not differ in gender (7/14, 50.0% male) or age (79.9 +/-8.9 years) from those participating in Phase 2.

3.2. Phase 1b: Initial assessment of potential dehydration screening variables

Little independent evidence has previously existed for many of the variables assessed here as potential screening parameters for dehydration.

3.3.1. Nutrition and hydration

No nutrition and hydration screening variables reached significant odds (Table1).

3.2.2. Swallow impairment

None of the proposed screening questions involving swallow impairment showed significant differences in odds, whether assessed with or without dehydration (Table1).

3.2.3. Mobility and functionality

The dehydrated were more likely to indicate they never had difficulties with the various parameters investigated, compared to well-hydrated participants. Variables that reached clinical significance if dehydrated compared with well-hydrated, included questions on mobility and pain (Table 2). The median time since the last fall was similar, whether assessed as dehydrated (1 month, range 0-30 years n = 25) or well-hydrated (1 month, range 0-9 years, n = 7).

3.2.4. Confusion and cognitive function

No screening questions for confusion and cognitive impairment were associated with dehydration (Table1). No-one assessed with dehydration had a MSQ

(Mental Status Questionnaire) score of six or less (Kahn et al., 1960; Seymour et al., 1980). No inappropriate responses suggestive of aphasia occurred when completing one-stage (Can you poke out your tongue?) or two-stage (Can you poke out your tongue and touch the chair) commands (n = 33).

3.2.5. Miscellaneous: Incontinence and impaired vision

The dehydrated were more likely than the well-hydrated to respond that they never limited what they drank to reduce the number of times they visit the toilet (Table 1). Everyone assessed with dehydration could read the first name on the hospital identification card (n = 7/7, 100%) compared with 77% of the well-hydrated (20/26).

3.2.6. Anxiety and depression

No anxiety and depression screening variables differed substantially between the groups (Table 1).

3.2.7. Fluid intake, thirst and headache

The dehydrated, compared to the well-hydrated, were more likely to indicate that they never felt thirsty (Table 2). None of those assessed as dehydrated (n = 0/7, median 0, range 0) reported headaches in the past week in comparison to 69.2% (18/26) of the well-hydrated (median 0, range 0-7). The odds of those with dehydration reporting they were “drinking the same as usual lately” as opposed to consuming “more” or “less” fluid lately did not substantially differ with hydration status. No participant indicated that they had ever been treated for dehydration (n = 33) and similar proportions of people in both the dehydrated (3/7, 42.9%) and well-hydrated (11/26, 42.3%) groups indicated that they disliked the taste of water (Table 1).

3.3. Phase 2: The final parameters to undergo assessment as a potential dehydration screen

Following Phase 1, the questions excluded from further investigation during Phase 2 due to no variation (response indicated in brackets) when dehydrated included: Do you have difficulty with feeling in your shoulder arms and hands? (never); Incontinence caused by walking or change in position (never); In the last 2

weeks, how often did you have difficulties turning taps on and off? (never); and question one of the General Health Questionnaire (Burns et al., 1999) regarding recent ability to concentrate (always, often or sometimes). Few remaining questions showed strong associations with hydration status during Phase 1.

Table 4 reports the dehydration screening questions investigated in Phase 2. In addition to the screening questions, physical parameters previously identified to have reached clinically significant differences with hydration status (Vivanti et al., 2008) were included. These physical parameters included tongue dryness, sternal skin turgor (2 seconds or more for skin to return to normal), a drop of 20 mm Hg or more in systolic blood pressure upon standing, and measured weight (<50 Kg if female, <70 kg if male).

Of the 86 participants involved during Phase 2 testing, 36 were clinically assessed as dehydrated (32 mild, 4 moderate). The results from those clinically assessed with mild or moderate dehydration were explored and found to be similar. Consequently, all dehydration was included in analysis to assess the usefulness in practice of the potential screening parameters. Responses in a contrary direction to the pilot study were rejected from further consideration (Table 5).

Due to limited mobility, blood pressure collection presented the most difficulties and resulted in the greatest number of missing data (25.6%, 22/86). The degree of missing physical measurement data confirmed difficulties in their use with the older, hospitalized person and consequently invalidated their viability as a screen. Tongue dryness was collected from all participants.

3.4. Phase 2: Multivariable analysis

Following Phase 2, associations between each of the final screening parameters tested and dehydration status were adjusted for the effects of age group, gender and BMI group (one at a time, since low sample size precluded a more comprehensive analysis). Age group and gender did not confound associations between hydration status and any of the final screening parameters. With the exception of tongue dryness and a question concerning pain interfering with daily activity, BMI group (less than 20, 20 or more) confounded associations between dehydration and the final potential screening parameters investigated (systolic blood pressure drop, sternal tissue turgor and difficulty moving shoulders, arms or hands) (Table 5).

3.5. Phase 2: Sensitivity and specificity assessment within the given sample

An assessment of tongue dryness completed with all 86 participants was the simplest and quickest to perform, could be completed with minimal cognitive or physical capacity and offered the most acceptable balance for clinical practice settings between sensitivity (64%, 95% CI 54-74%) and specificity (62%, 95% CI 52-72%) in the given sample of study participants. No practical improvement in sensitivity and specificity of tongue dryness was evident when combined with either/or of the next strongest parameters: pain interfering with daily activities (sensitivity 83%, 95% CI 76-90%, specificity 32%, 95% CI 23-43%) and drop in systolic blood pressure on standing (sensitivity 69%, 95% CI 59-79%, specificity 56%, 95% CI 46-66%). The sensitivity and specificity of skin turgor alone was 44% (95% CI 34-54%) and 65% (95% CI 55-75%) respectively. There was no difference in the screen's performance when those assessed with mild dehydration only were analyzed separately to those with combined mild and moderate dehydration.

3.6. Phase 3: Repeatability of final screen

Following Phase 3, inter-rater repeatability of the potential screen ranged from 70% to 95% agreement. Agreement on dry tongue assessment by two experienced nursing staff occurred in 70% (16/23) of both the initial and repeat assessments (kappa=0.46, 0.39 respectively). Agreement between the study's physician and one nursing staff member was 95% (19/20) upon the initial assessment and 70% (14/20) on repeat assessment (kappa=0.90, 0.37 respectively). With minimal training, agreement between the study's physician, author or pharmacist achieved 90% (9/10), and nursing staff achieved 100%, (10/10) (Kappa = 0.62, 1.0 respectively).

Despite requesting participants to abstain from drinking until the second assessment, many participants were observed and others admitted to sips of fluid between assessments, thus preventing confirmation of inter-rater repeatability assessment. Of 11 participants observed to drink, 71% (5/7) initially assessed with a "dry" tongue, were reassessed as "not dry" by both practitioners subsequent to the drink.

4. Discussion

4.1. Development of a potential dehydration screening method

This study aimed to develop a clinically practical means to quickly identify older people at risk of poor hydration. An assessment of tongue dryness is simple, quick and needs minimum co-operation, enabling its use with all older people in care regardless of cognitive or physical capacity. Results are immediate, and require no preparation of screen or participant, in contrast to the only other previously-published dehydration screening method which assessed axillary moisture 24 hours after avoidance of antiperspirant (Eaton et al., 1994).

4.2. Implications of certain screen responses

Responses to some potential screening questions contrast with opinions held concerning dehydration risk. Dehydrated study participants did not report increased incontinence or drinking less to reduce the number of bathroom visits, in contrast to perceptions that older people in institutional care restrict fluid to reduce urination frequency, incontinence, dependence on nursing assistance and risk of embarrassment caused by incontinence (Adams, 1988; Bidlack and Wang, 1995; Sansevero, 1997). Whether response bias occurred remains to be confirmed.

Participant responses indicated caffeinated beverages were valuable sources of daily fluid. There appears little justification for avoiding caffeine-containing drinks for those consuming little fluid, as a physiological adaptation occurs with habitual moderate intake of coffee, tea or other caffeinated beverages (Maughan and Griffin, 2003). Discouraging habitual consumption of caffeinated beverages does not appear warranted and may compromise fluid consumption, especially if at risk of dehydration (Maughan and Griffin, 2003).

4.3. Further validation of the potential screen

The potential dehydration screen was assessed against global clinical dehydration assessments. Therefore, the possibility exists that the parameters most associated with dehydration may simply reflect those most employed by the physician during clinical dehydration assessments. Even though independent verification of clinical dehydration assessment was offered by weight shifts occurring in directions that were consistent with the changes in hydration status and more than

one consultant completed Phase 2 assessments, alternative means of tool verification are required.

Validation could be confirmed through clinical, predictive, or criterion means. Clinical validity would explore the relationship between a screen, consisting of parameters not used in the clinical assessment, and known parameters associated with the condition. This has proved difficult to confirm as there are no standard or widely-accepted means for the clinical assessment for fluid deficit. Predictive validity could be used to establish an association between the potential screen and a future event, such as morbidity, 30 day or one year mortality (Warren et al., 1994). Criterion validity could assess the potential screen against a gold standard measure. The most accepted process for confirming fluid deficit is assessing body fluid loss by weight change as a percentage of total body weight (Weinberg and Minaker, 1995; Murphy, 1998), impractical in the geriatric clinical setting.

4.3.1. Difficulties with criterion validity

Although short-term weight change may be considered the gold standard, animal models show that dehydration involves intricate physiological responses, with extracellular water shifts between interstitial and vascular compartments, expediential losses of intracellular water with increased dehydration, and preferential intracellular water losses from certain tissues, all adding to the complexity of understanding dehydration and its assessment. (Senay, 1972; Denny and Dawson, 1975; Nose et al., 1983). Both human (Senay and Christensen, 1965; Sarhill et al., 2001; Thomas et al., 2003) and animal literature (Denny and Dawson, 1975; Horowitz et al., 1978; Horowitz and Samueloff, 1979; Nose et al., 1983; Zurovsky et al., 1984) reveals dehydration as a complex and dynamic process with degrees of physiological compensation.

4.3.2. Difficulties with clinical validity

No standardized clinical dehydration assessment method exists (Warren et al., 1994). In clinical practice, there is a tendency to interchangeably use the terms ‘dehydration’ and ‘volume depletion’ (Mange et al., 1997; Thomas et al., 2003). A diagnosis of dehydration is often made without biochemistry to support the decision and without aggressive treatment, which suggests that fluid deficit in the form of volume depletion rather than intra-cellular dehydration is present (Thomas et al.,

2003). Consequently, many hospitalized people referred to as “dehydrated” are probably volume depleted (McGee et al., 1999; Thomas et al., 2003). Due to the lack of elevated serum sodium or osmolality in Phase 1 (Vivanti et al., 2008), it is likely that this prospective tool was developed amongst those with volume depletion.

4.3.3. Difficulties with predictive validity

The consequences of dehydration are serious and include cognitive impairment, functional decline and death amongst older people in care. Dehydration is linked with high inpatient mortality (ranging in studies from 12% to 71%) (Long et al., 1991; Faunt et al., 1995; Molaschi et al., 1997) and increased 2-year mortality (O'Neill et al., 1990; Molaschi et al., 1997). The morbidity and mortality rates associated with hypernatraemic dehydration in care was reported to be 45% or higher (Himmelstein et al., 1983) with elevated serum sodium (OR 1.31, 95% CI 1.06-1.61) an independent risk for mortality (Molaschi et al., 1997).

Dehydration has also been associated with morbidity including functional decline and delirium. Dehydration was identified as one of four predisposing risk factors for delirium in older hospitalized people (Inouye, 2000). A hospital discharge diagnosis of dehydration was shown to be one of the six most common diagnoses for older people in the population (n = 6070) who went on to develop progressive disability and who then required institutional care in the following year (Ferrucci et al., 1997). However, causes of morbidity and mortality are multifactorial, with hydration status being one of several contributors to outcome.

4.4. Repeatability of potential screen

Minimal training increased agreement in the assessment of tongue drynesss to between 90-100%. Even without training, the 70-95% agreement with dry tongue assessment is acceptable compared with other studies involving clinical judgment reporting 75-81% agreement (Baker et al., 1982; Eaton et al., 1994; Wakefield et al., 2002). Initial results were obtained with no training, protocols or attempts at practitioner standardisation in order to mimic inexperienced application. Our study also supports other’s findings where the introduction of standard protocols substantially increased agreement in urine color assessments from 75% to 95% (Wakefield et al., 2002).

4.5. Limitations

There were relatively few published papers investigating the factors most related to hydration status. Few studies may exist or studies with negative results may remain unpublished (Easterbrook et al., 1991; Song et al., 1999). Most variables selected for investigation as potential screening questions were "expert opinion".

A heterogeneous sample may have been explored. No distinction was made between intracellular dehydration and volume depletion. None of the participants were assessed as severely dehydrated and mild dehydration was confirmed as the most common presentation. The effect of drink proximity upon the assessment of tongue dryness also needs to be established.

Clinical validity was difficult to establish due to the lack of a verified standard for clinical dehydration assessment. Although professional judgment had limitations, it provided a basis upon which to commence developing simple ways to identify poor hydration in a clinical setting.

Due to practical considerations, a purposively selected group of participants were selected for Phase 2. This signifies that the estimates of sensitivity and specificity relate only to the study participants are not generalizable at this stage.

The sample size was small considering the large number of parameters investigated, and hampered our attempts to explore confounding with confidence. Given the paucity of published literature, the exploration of many variables was deemed valuable. A larger sample size would enable development of models through regression analysis or further exploration of potential confounders. This preliminary study enables power calculations to estimate numbers required for prospective studies to validate the screen in target populations.

4.6. Study strengths

The identification of one simple parameter most associated with poor hydration status is considered a successful preliminary result. The potential screen can be completed by minimally trained health professionals and does not require a physician to perform.

This study addressed a clinically practical question under real clinical conditions. Indicators of dehydration that could be obtained with relative ease in a clinical setting were investigated. A combination of qualitative and quantitative techniques enabled an account of current practice to be compared with independent clinical data.

The study explored a target population destined as a growth area for health services. No significant clinical differences in age or gender were identified amongst study participants and the remainder of GARU. Additionally, the representativeness of the older participants from GARU compared with the hospital was confirmed, and our results may be considered at least generalizable to our local population.

The effect of potential confounders on the association between tongue dryness and dehydration was mentioned but not explored by other authors (Gross et al., 1992; Eaton et al., 1994). Our study results are the only known to have attempted to adjust for potential confounding effects of gender, age or BMI upon the association between the parameter under investigation and clinically assessed dehydration.

4.7. Benefits of screening

In residential care, dehydration has been proposed as an indicator of the quality of care (Himmelstein et al., 1983; Fries et al., 1997; Thomas et al., 2003). Without screening, care and treatment plans to restore and maintain hydration are unlikely to be implemented and the condition may remain unresolved. The parameter of dry tongue alone provided the optimal mix of sensitivity and specificity in the study participants and could be implemented at no cost with all older people in care, regardless of medical, physical or cognitive considerations.

4.8. Recommendation for future research

Despite the acknowledged limitations, valuable information towards developing a simple dehydration screening method for validation has been provided by this descriptive preliminary study. An assessment of criterion (short–term weight change) or predictive (morbidity or mortality) validity would provide additional evidence of the potential screen's value. The need remains to ascertain the sensitivity, specificity, positive and negative predictive values of the parameter most strongly associated with poor hydration status in populations of older people including acute care, longer-term care and community dwelling.

5. Conclusions

This study documented the associations, between global clinical assessments of dehydration, and a number of individual parameters, potentially useful to screen for poor hydration upon admission to hospital. Tongue dryness may offer a simple,

quick, and reliable way to identify an older person's risk of dehydration in clinical care. The potential screen's 100% completion rate confirms extremely high acceptability with the older tertiary hospital population. It can be completed at no cost and regardless of physical or communicative ability. Additionally, there is no preparation, delay or laboratory testing required, thus offering possible additional applications to rural and remote areas, during natural disasters or emergencies, as well as extension to visual electronic media. Validation in larger and varied populations of older people is required.

Conflict of interest statement: None.

Acknowledgements

We are grateful to Diana Battistutta for her support and guidance through many aspects of this study. We thank Mike Roberts, Paul Varghese, Phil Aitken, David Johnson, Ian Scott, Glenise Berry, Peter Harvey, Glenda Powell, Carmel Hawley, Anne White, Margie Morton and Maria Dos Santos for their involvement at various stages throughout the study. The generous assistance received from the Health Information Management Departments of The Prince Charles Hospital and the Princess Alexandra Hospital is also gratefully acknowledged. Support from a PA Foundation grant is appreciated and acknowledged.

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Table 1.

Unadjusted OR of mild dehydration with questions of statistically not significant parameters (from Phase 1)

Odds ratio (OR)*	Potential dehydration screening question tested (Unless indicated: no dehydration: n = 26; mild dehydration n = 7)
Increased odds of dehydration (fluid deficit), unadjusted OR = 1 < 2	
Nutrition and hydration	**Malnutrition screening tool score:at risk (2+) (Ferguson et al., 1999)
	How often does your mouth feel dry? (nil = 25)
	Do you feel refreshed after a drink? (nil = 24)
Mobility and functionality	Walking without a stick or frame to stay steady? (nil = 25)
	Do you ever feel dizzy?
	How often in the past 2 weeks did you feel weak?[b]
	- have problems with walking? [c] (nil = 25, mild = 6)
	have problems washing and dressing yourself? [c]
	problems performing your usual activities, e.g. work, housework family, leisure activities? [c]
	have trouble taking a short walk outside of the house? [b]
	need more rest breaks? [b]
	need help eating, dressing or washing yourself? [b] (mild = 6)
	Q27 EORTC QLQ-C30 (Aaronson et al., 1993) concerning condition or treatment affecting social life (nil = 23)
	In the last 2 weeks, how often did you have difficulty opening packages & bottles?
Incontinence	In the past 2 weeks did any of the following activities coincide with incontinence: Coughing, laughing, physical strain?
Vision	How often do you have difficulty drinking from a cup or a glass?
Anxiety and depression	In the past 2 weeks, how often did you feel tense?
	Has your memory changed?
Thirst	Do you dislike the taste of water?
	How often does your mouth feel dry? (nil = 25)
	Do you feel refreshed after a drink? (nil = 24)
Unadjusted OR = 2 < 3	
Nutrition and hydration	Is food as tasty as it used to be?
Mobility and functionality	Do you have difficulty moving your legs including your hips, knees, ankles or feet? (nil = 25)
	Getting to the toilet? (nil=24)
	Q26 EORTC QLQ-C30) (Aaronson et al., 1993) concerning condition or treatment affecting family life (nil = 23)
Vision	Do you feel confident pouring hot water?
Anxiety and depression	Do you have difficult watching TV, a movie or reading a book? (mild = 25)
Thirst	How thirsty do you feel now?
	Is food as tasty as it used to be?
Unadjusted OR = 3 < 4	
Nutrition and hydration	**Q1 Malnutrition screening tool (Ferguson et al., 1999) concerning recent weight loss
Mobility and functionality	Do you have difficulty with feeling in your legs including your hips, knees, ankles or feet? (nil = 25)
	How often in the past 2 weeks did you feel tired? [b]
	In the past 2 weeks how often were you limited in doing either your work or other daily activities? (nil = 22, mild = 3) [b]
Incontinence	Do you limit the amount you drink to reduce the number of times you visit the toilet?

Table 1. (continued)

Increased OR of dehydration (fluid deficit)	
Unadjusted OR <1	
Nutrition and hydration	** Have you had trouble eating in the last few weeks because of decreased appetite or problems with swallowing or chewing food? [d]
Swallow impairment	Do you have difficulty swallowing food? Do you have difficulty swallowing liquids? Does food or fluid ever go down the wrong way? Do you avoid any foods or fluids? (nil = 25, mild = 6)
Mobility and functionality	Do you have difficulty moving your shoulders, arms or hands? In the past 2 weeks how often - were you limited in hobbies or leisure activities? (nil = 23, mild = 5) [b] did you have difficulty carrying a liter of milk in just one hand?
Anxiety and depression	In the past 2 weeks, how often did you feel worried? [b] depressed? [b] irritable? [b] Do you ever have difficulty remembering?
Uninformative [a]	
Anxiety and depression	**Q1 GHQ-12 (Burns et al., 1999) regarding recent ability to concentrate

OR of mild dehydration if:
* responding "never" to the parameter under investigation relative to "always often or sometimes".
** if responding "yes" to the parameter under investigation relative to "no".

[a] OR unable to be calculated as nil events occurred in one or other of the study groups
[b] Modified from EORTC QLQ-C30 (Aaronson et al., 1993)
[c] Modified from Euro Qol (EQ-5D) (The EuroQol Group, 1990)
[d] Modified from malnutrition screening tool (Ferguson et al., 1999)

Table 2.

Dehydration screening questions that underwent further investigation

(No dehydration n = 25, mild dehydration n = 7) (from Phase 1)

	OR*	95% CI
Mobility and functionality		
Do you have difficulty moving your shoulders, arms or hands?	0.2	0.04 - 1.5
How often in the past 2 weeks did you have problems with pain of any kind? [a]	6.5	0.7 - 62.1
In the past 2 weeks how often did pain interfere with your daily activities? [b]	7.0	0.7 - 66.6
In the last 2 weeks, how often did you drop something?	6.5	0.7 - 62.1
Thirst		
Do you ever feel thirsty?	5.3	0.9 - 31.9
Did you feel thirsty yesterday?	4.7	0.7 - 29.4

*OR of mild dehydration if responding “never” to the parameter under investigation relative to “always, often, or sometimes”

[a] Modified from Euro Qol (EQ-5D) (The EuroQol Group, 1990)

[b] Modified from EORTC QLQ-C30 (Aaronson et al., 1993)

Table 3.

Comparison of screening questions related to incontinence amongst those assessed with or without dehydration (from Phase1)

	No dehydration			Mild dehydration		
	n	median	range	n	median	range
Yesterday, how often did you visit the toilet during the day?	23	4.00	1-20	6	4.50	2-20
Yesterday, how often did you visit the toilet at night?	22	1.50	0-10	6	3.50	0-6
How many glasses of alcohol did you drink yesterday?	28	0.00	0-3	7	0[a]	0[a]
How many glasses of tea or coffee did you drink yesterday?	26	4.00	0-6	7	3.00	0-6
How many glasses of other fluid did you drink yesterday?	28	5.00	1-19	7	5.00	1-50
When did you last have something to drink? (hours)	23	1.50	0-5	7	2.00	1-5

[a]Unable to be calculated as no consumption reported amongst those assessed with mild dehydration.

Table 4.
Final dehydration screening tool questions selected for further testing (for Phase 2)

1. Record SBP in a lying position: If sitting, need to be supine for more than 2 minutes SBP on lying = _____(mmHg)		
If able, ask client to stand during the following questions:		
2. Inspection of tongue for dryness	Normal Dry Very dry Unable to complete	[ ] [ ] [ ] [ ]
3. Sternum skin turgor (timed using a second hand) Upon pinching, note the number of seconds for skin to return to normal	0 or 1 second 2 or more seconds Unable to complete	[ ] [ ] [ ]
4. Do you ever feel thirsty?	Yes No Unable to complete	[ ] [ ] [ ]
5. Did you feel thirsty yesterday?	Yes No Unable to complete	[ ] [ ] [ ]
6. Do you have difficulty moving your shoulders, arms or hands?	Yes No Unable to complete	[ ] [ ] [ ]
7. In the past 2 weeks, did pain interfere with your daily activities?	Yes No Unable to complete	[ ] [ ] [ ]
8. In the past 2 weeks did you have problems with pain of any kind?	Yes No Unable to complete	[ ] [ ] [ ]
9. In the last 2 weeks, did you drop something?	Yes No Unable to complete	[ ] [ ] [ ]
10. How many times have you had a headache in the past week?	On 1 < occasions No occasions Unable to complete	[ ] [ ] [ ]
11. Once 2 minutes has elapsed since standing, Record SBP in the standing position: Client can now be seated again	SBP on standing: _____ (mmHg)	

12. The change in SBP on standing	No, or increase	[ ]
	Decrease up to 20 mmHg	[ ]
	Decrease 20-29 mmHg	[ ]
	Decrease 30 mmHg or more	[ ]
	Unable to complete	[ ]
13. Weight (measured), if female,	50 kg or more	[ ]
	under 50 kg	[ ]
if male	70 kg or more	[ ]
	under 70 kg	[ ]
	unable to complete	[ ]

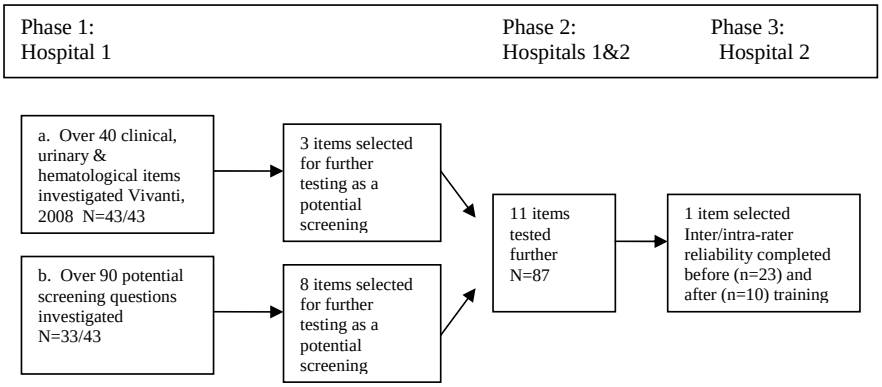

Figure 1.

Flow chart of study design during development of a potential dehydration screening method.

Table 5.

Comparison of individual potential screening parameters against clinically assessed hydration status (from Phase 2)

Parameters/Groups	No dehydration		Dehydration		Unadjusted		Adjusted for age group[d]	Adjusted for gender	Adjusted for BMI group[e]	
	N	n(%)	N	n(%)	N	OR (CI)	OR (CI)	OR (CI)	N	OR (CI)
Dry tongue	50	19 (38.0)	36	23 (63.9)	86	2.9 (1.2-7.0)	2.9 (1.2-7.0)	2.9 (1.2-7.0)	84	3.2 (1.3-8.1)
Sysytolic BP change on standing (drop of 20 mmHg or more)	42	4 (9.5)	26	5 (19.2)	68	2.3 (0.5-9.3)	2.4 (0.6-10.4)	2.2 (0.5-9.1)	68	2.0 (8.5-8.7)[f]
Sternal skin turgor (2+ sec)	49	17 (34.7)	36	16 (44.4)	85	1.5 (0.6-3.6)	1.5 (0.6-3.7)	1.5 (0.6-3.6)	85	1.3 (0.5-3.4)[f]
In the past 2 weeks, did pain interfere with your daily activities? (yes)	49	24 (49.0)	32	20 (62.5)	81	1.7 (0.7-4.3)	1.7 (0.7-4.4)	2.0 (0.8-5.1)	79	1.8 (0.7-4.6)[f]
Do you have difficulty moving your shoulders, arms or hands? (no)	50	32 (64.0)	34	24 (70.6)	84	1.4 (0.5-3.4)	1.3 (0.5-3.4)	1.4 (0.5-3.5)	82	1.7 (0.6-4.4)[f]
[b]Do you ever feel thirsty? (no)	50	20 (40.0)	33	8 (24.2)						
[b]Did you feel thirsty yesterday? (no)	50	27 (54.0)	33	14 (43.8)						
[b]In the past 2 weeks did you have problems with pain of any kind? (no)	49	18 (36.0)	32	13 (38.2)						
[b]In the last 2 weeks, did you drop something? (no)	45	28 (62.2)	30	18 (60.0)						
[c]Lower weight	49	14 (28.6)	36	12 (33.3)						
[b]How many times have you had a headache in the past week? (nil)	48	32 (66.7)	32	21 (65.5)						

Notes: N: total number; CI: 95% confidence interval; [a]Percentage equates to sensitivity; [b]Indicates responses in direction opposite to pilot study responses and consequently rejected; [c]Female: 50 kg or more vs less than 50 kg, male: 70 kg or more vs. less than 70 kg; [d]Age groups: less than 80 years and 80 years or more; [e]BMI groups: less than 20 and 20 or more; [f]Confounding considered considerable as adjusted value differed from unadjusted value by more than 10%.

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