

# The hydration status of people with and without cognitive impairment within an acute care environment



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Translating dementia research into practice

*Final Report for the Hydration Study*

# The hydration status of people with and without cognitive impairment within an acute care environment

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Dr Judy McCrow  
[Judy.mccrow@cofcqld.com.au](mailto:Judy.mccrow@cofcqld.com.au)



**Table of Contents**

<b>LIST OF FIGURES.....</b>	<b>III</b>
<b>LIST OF TABLES .....</b>	<b>IV</b>
<b>ACKNOWLEDGEMENTS.....</b>	<b>V</b>
<b>SECTION 1. EXECUTIVE SUMMARY.....</b>	<b>1</b>
<b>SECTION 2 .....</b>	<b>3</b>
<b>BACKGROUND .....</b>	<b>3</b>
<b>SIGNIFICANCE.....</b>	<b>5</b>
<b>AIM.....</b>	<b>7</b>
<b>SECTION 3. METHODS .....</b>	<b>8</b>
Design.....	8
Participants.....	8
<b>MEASURES.....</b>	<b>8</b>
<b>ETHICAL CONSIDERATIONS .....</b>	<b>13</b>
<b>STUDY PROCEDURE .....</b>	<b>13</b>
<b>DATA ANALYSIS .....</b>	<b>15</b>
<b>OUTCOME MEASURES.....</b>	<b>17</b>
<b>SECTION 4. RESULTS.....</b>	<b>18</b>
Baseline Characteristics of the sample.....	18
RUDAS.....	18
Frailty .....	20
Alcoholol intake .....	22
Other Baseline Characteristics.....	22
Baseline comparisions of participants without cognitive impairment (non-CI) and those with cognitive impairments (CI) .....	23
Biochemical results.....	26
Question 1 and 2: Hydration status.....	27
Clinical assessment for hydration status .....	27
Weight loss > 3% .....	27

Serum Osmolalities measures for hydration status .....	28
Serum Sodium measures for potential dehydration .....	29
Comparisons between clinically assessed dehydration and serum osmolality (categories) .....	30
Positive identification of potential dehydrations by combined serum osmolality or clinical assessment, dehydration markers.....	31
Comparisons between frailty and hydration status .....	33
Frailty and serum osmolality results .....	35
Frailty and weight loss.....	38
Frailty and combined dehydration markers .....	39
Length of stay .....	41
Discharge destination .....	41
Readmissions/Falls/Pressure injuries/mortality.....	41
<b>SECTION 5. Question 3. Barriers and Enablers .....</b>	<b>44</b>
Fluid intake dependency .....	44
Observational assessment results .....	45
Meal time assessments.....	46
Chart Audit.....	48
General Observational Findings .....	49
<b>SECTION 6. DISCUSSION .....</b>	<b>52</b>
<b>CONCLUSION .....</b>	<b>63</b>
<b>PUBLICATIONS .....</b>	<b>64</b>
<b>SECTION 7. REFERENCES.....</b>	<b>65</b>

**List of figures**

Figure 1. Percentage of participants in each group at baseline (n=44) ..... 19

Figure 2. RUDAS scores of participants (n=37) ..... 19

Figure 3. Assessed Frailty classifications for all participants (n=44) ..... 20

Figure 4. Clinical Frailty Scale classification for participants in the CI and Non-CI groups ..... 20

Figure 5. Percentage of participants from the CI and Non-CI groups who were either "fit" or "frail" (n=44) ..... 21

Figure 6. Percentage of participants from each group who were either "fit" or "frail" (n=44) ..... 21

Figure 7. Participants hydration status via serum osmolality ..... 28

Figure 8. Hydration status of participants in both the "fit" and "frail" categories at baseline (n = 41) ..... 33

Figure 9. Hydration status of participants in both the "fit" and "frail" categories at exit (n = 32) ..... 33

Figure 10. Dehydration Osmolality markers & frailty category at baseline (n=41) ..... 36

Figure 11. Dehydration Osmolality markers & frailty category at exit from study (n=31) ..... 36

Figure 12. Number of categorized "fit" and "frail" participants within each serum osmolality hydration category at baseline (n = 41) ..... 37

Figure 13. Number of categorized "fit" and "frail" participants within each serum osmolality hydration category at exit from study (n=30) ..... 37

Figure 14. Numbers of participants with or without dehydration (all markers) within each frailty category at baseline (n = 41) ..... 39

Figure 15. Numbers of participants with or without dehydration (all markers) within each frailty category at exit from study (n = 35) ..... 39

Figure 16. Observed fluid intake dependency for all participants (n = 39) ..... 46

Figure 17. Position of patient during meal time assessment ..... 48

**List of tables**

Table 2. Data collection information .....	12
Table 3. Other Baseline Characteristics & Data .....	22
Table 4. Dehydration risk appraisal: Average number of risk items per category (n=40).....	23
Table 5. Baseline comparisons between non-CI and CI groups.....	25
Table 6. Paired t-test results from baseline to exit from study for total sample.	26
Table 7. Dehydration category via clinical assessment in the non-CI and CI groups .....	27
Table 8. Dehydration category via baseline and exit serum osmolality in the CI and non-CI groups.....	29
Table 9. Comparisons between clinical assessments and serum osmolality hydration categories at baseline (n=39) .....	30
Table 10. Comparisons between clinical assessments and serum osmolality hydration categories at exit (n=28) .....	30
Table 11. Follow up of participants in relation to hydration status and exit from study.....	32
Table 12. Baseline dehydration using combined markers and frailty classifications (n=41).....	34
Table 13. Exit dehydration using combined markers and frailty classifications (n=32).....	34
Table 14. Mean serum osmolality within each frailty category for the non-CI participants.....	35
Table 15. Mean weight differences for participants within each Clinical Frailty Scale item.....	38



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## **RESEARCH ASSISTANTS**

Mrs Rosalee Trent

Ms Rachel McCrow

Ms Althea Irwin

## **PROJECT INVESTIGATOR TEAM**

Doctor Judy McCrow - DCRC-CC Adjunct Research Fellow & Clinical Practice Development Facilitator, Churches of Christ Care in Queensland

Ms Margaret Morton - Senior Clinical Research Coordinator – Internal Medicine & Dementia Research Unit, the Prince Charles Hospital

Doctor Keren Harvey - Acting Medical Director, Geriatric and Rehabilitation Medicine & Senior Staff Specialist Geriatrician and Senior Lecturer, University of Queensland

Doctor Eamonn Eeles - Consultant Physician in Geriatrics and Internal Medicine and Senior Lecturer, University of Queensland

## **SECTION 1. EXECUTIVE SUMMARY**

While dehydration is common in older patients and is associated with poor outcomes, it has been infrequently studied in the hospital setting. Thus, the main aims of this study were to assess the prevalence of dehydration in people with and without cognitive impairment within an acute care environment and investigate the barriers to the maintenance of adequate hydration in older patients in an acute hospital environment. Additional study aims were to examine associations between dehydration, cognitive impairment (CI) and frailty, and to assess the diagnostic accuracy of clinically assessed dehydration in older hospital patients versus dehydration using serum-calculated osmolality as the reference standard.

### **Method**

A prospective, observational study of 44 patients aged 60 years and older admitted to the internal medical unit of a large teaching hospital in South-East Queensland was undertaken. Recruitment occurred between July 2013 and November 2014. Dehydration was assessed within 24 hours of admission and at day 4 or at discharge, whichever occurred first (study exit). Patients' cognitive function and frailty status were assessed using validated instruments. Patients were observed during mealtimes, and chart and room audits were performed to identify hydration management strategies, weight records and the presence or absence of fluid balance charts.

### **Summary of Results**

The prevalence of dehydration at admission was 29% (n=12) and 19% (n=6) at study exit and dehydration status did not differ according to either cognitive status (CI versus no CI) or frailty (fit versus frail) status. Within the non-CI group, however, significantly more frail than fit patients were dehydrated at admission (p=0.03), and dehydration at admission significantly predicted dehydration at exit (p=0.01).

A comparison of two measures of dehydration: clinically assessed dehydration and dehydration using serum-calculated osmolality (the most frequently used

reference standard) showed that agreement between the measures was fair at admission and poor at exit. Clinical assessment showed poor sensitivity for predicting dehydration with reasonable specificity.

Results of the observational study revealed a number of system and practice-related barriers including patient difficulties with opening fluid containers, inadequate documentation of hydration management strategies and a lack of staff assistance.

### **Conclusions**

Dehydration appears to be common in older medically ill patients admitted to hospital, in patients both with, and without cognitive impairment. Frailty may increase the risk for dehydration in cognitively intact older patients and our findings highlight the importance of formally assessing older patients for dehydration at admission to hospital and throughout their hospital stay.

Compared to the use of serum-calculated osmolality, the clinical assessment of dehydration was poor and it is recommended that clinicians should not rely upon the clinical assessment of dehydration, without also using the reference standard. To do so may result in failure to identify dehydration in this population with potentially serious consequences.

Finally, addressing the system and practice-related barriers identified in this study is an important first step towards improving the management of hydration in medically ill older hospital patients.

## **SECTION 2**

### **Background**

Australians place significant value on the availability of high quality and cost effective health care, especially for older people. This priority is reflected in current government and health regulatory requirements that encourage equity of access and a minimum standard of service quality. However, as older people enter our health care environments, resources will be stretched. This effect is not only because demand will increase by virtue of the ageing of the population, particularly in Queensland, but also because older patients typically present with multiple co- morbidities and complex, high care needs. (Amella, 2004).

Frailty is a term used to refer to people who are at a risk state because of the age-associated accumulation of deficits (Mitnitski, Mogilner, & Rockwood, 2001). For frail older people there is a significant number who have cognitive impairments such as dementia and delirium. These people are at most risk of dehydration and associated poor outcomes (Ullrich & McCutcheon, 2008). We know that some older people have a degree of dehydration when they enter hospital and it is hypothesised that there is a higher prevalence of dehydration for people with cognitive impairments both on admission and throughout their hospitalisation (Vivanti, Harvey, Ash, & Battistutta, 2008). Therefore, this project was based on the growing need for care of this population of people and advancing practice to improve patient outcomes.

Research has shown that dehydration is common in older adults and is particularly frequent amongst those admitted to hospital with prevalence rates of between 21 and 44% reported (El-Sharkawy, Sahota, Maughan, & Lobo, 2014; Fortes et al., 2015). Dehydration is associated with a range of serious adverse events in this population including falls, delayed wound healing, behavioural changes and even death (Hodgkinson, Evans, & Wood, 2003; J. Menten, 2006b). Other consequences of dehydration in a hospitalised older people include constipation, medication toxicity, urinary tract infections and respiratory tract infections (J. Menten, 2006b). In addition to the impact these complications have on the patient and his or her family they also are associated with

increased hospital costs such as staffing, resources, medications, rehabilitation services, pathology and radiology. Importantly dehydration is considered an indicator of poor care as the greatest risk for dehydration is poor oral intake (Kayser-Jones, 2002; Woodward, 2007). Within clinical practice dehydration “refers to the loss of body water, with or without salt, greater than the body can replace it” (Thomas et al., 2008). To diagnose dehydration requires information about the person from a variety of sources including pathology testing, clinical assessment and information about the persons history (Thomas et al., 2008).

Dehydration in older people is usually associated with increases in fluid loss with a decrease in fluid intake (Thomas et al., 2008). Although it is suggested that dehydration is not a result of lack of access to water the acute care environment places many challenges in relation to accessing fluids for older people (Thomas et al., 2008). Accessing adequate fluids in hospital can be difficult for this population of people for a number of reasons, some of which are likely to be health system-related (Simmons, Alessi, & Schnelle, 2001). Such factors could include whether drinks are within easy reach of the patient, given with required aids (e.g., a straw or sipper cup), presented at ‘normal’ drink times, such as together with food, made according to personal preference, supplied together with information about the importance of hydration. However, when people have cognitive impairments, such as delirium or dementia, the problems are further exacerbated.

While hydration was been explored in older people in acute care it has been seldom been explored in people with cognitive deficits within an acute care environment. Dehydration in an older patient with both acute and chronic cognitive impairments such as delirium and dementia is often related to a reduced fluid intake (Forsyth et al., 2008). While this population often appear capable of drinking adequate fluids however, for a variety of reasons, including changes in environments, changes in functional status, memory impairment and confusion, they do not do so (Hodgkinson et al., 2003; Ullrich & McCutcheon, 2008).

## **Significance**

Delirium and dementia are both frequently found in older hospitalised patients. Although some symptoms and characteristics of each may appear similar, different mechanisms are responsible for the changes in behaviour seen (Insel & Badger, 2002). Delirium is a serious, largely reversible acute confusional state associated with high morbidity and mortality in older hospitalised people (S.K Inouye, 2006; McCusker, Cole, Abrahamowicz, Primeau, & Belzile, 2002). It manifests as an acute impairment in cognition and attention with alterations in sleep-wake cycles and psychomotor behaviour (American Psychiatric Association, 2000). In contrast, dementia is a syndrome of progressive, usually gradual cognitive decline (Insel & Badger, 2002). It is characterised by multiple cognitive deficits that include impairment in memory, emergence of behavioural disturbances and interference with daily function and independence, which tend to persist in an unchanged form for longer than a few months (American Psychiatric Association, 2000). Dementia and delirium are common in older hospitalised patients and are highly interrelated. When delirium is evident in a person with dementia it is referred to as delirium superimposed on dementia (Fick, Agostini, & Inouye, 2002; Shapiro & Mervis, 2007). A common element in both disorders is cognitive impairment, thereby representing a group of people where dehydration is a potential problem within acute care environments.

Research shows that older people are at risk of dehydration because of various physiological age-related changes such as changes in the water and sodium balance, which may be attributable to multimorbidity and polypharmacy, and loss lack of the thirst sensation (Scales & Pilsworth, 2008). However, healthy older people are usually capable of consuming adequate fluids to stay hydrated however when patients are frail and have cognitive impairment they may lack the drive and capacity to obtain oral fluids even if they are thirsty. The risk of dehydration is further exacerbated in the presence of an acute illness and behavioural disturbances. Consequently, there is often reliance on health care workers to ensure patients with delirium and dementia receive adequate hydration during their acute care stay. Anecdotally, health care workers suspect that this population of people may not be achieving adequate hydration whilst in

an acute care environment however, there is currently a lack of empirical evidence to support the claim.

This study was important as there is a gap in published literature identifying the hydration status of cognitively impaired older people in hospital. Additionally, while it may seem obvious that specific fluid monitoring systems should be in place for these people, we don't know what mechanisms, if any, are currently in place within hospitals to firstly monitor the hydration status of this group of people and secondly what clinical practices are in place to ensure adequate hydration is provided. The study first investigated the hydration status of older patients with cognitive impairment both on admission and during their hospitalisation, and also investigated barriers and potential enablers to the maintenance of adequate hydration in this population. Additional study aims were to examine associations between dehydration, cognitive impairment and frailty. Finally, as clinicians frequently rely upon their own clinical assessment to diagnose dehydration [in some settings for example, rural and remote hospitals ready access to pathology services may be limited and it may take several hours to obtain pathology results], it is important to know the accuracy and reliability of the clinical assessment of dehydration. Hence, we compared the diagnostic accuracy of clinically assessed dehydration against dehydration assessed using serum-calculated osmolality which is the most commonly used reference standard.

## **Aim**

The aim of this study was to determine the extent of the problem of dehydration in people with and without cognitive impairment within an acute care environment and investigate the barriers to adequate hydration.

Research Questions were:

1. What is the hydration status of older people with and without cognitive impairment when they enter an acute care environment and does this change over the first few days of hospitalisation?
2. Are findings different for people with cognitive impairment compared to those without cognitive impairment?
3. Are there important relationships between cognitive impairment, frailty and dehydration, and if so, what are these relationships?
4. What are identifiable barriers and enablers to adequate hydration for older people in an acute care hospital environment? and
5. What is the diagnostic accuracy of clinically assessed dehydration in older hospital patients versus dehydration using serum-calculated osmolality as the reference standard.



## **SECTION 3. Methods**

### **Design**

This study was a prospective repeated measures design. The setting was a major tertiary care referral hospital in South-East Queensland, Australia.

### **Participants**

A convenience sample of both non-cognitively and cognitively impaired patients newly admitted to internal medical services within a major tertiary referral hospital were recruited for this study. Participants were recruited on an adhoc basis as determined by the availability of the research team.

Inclusion criteria included: a) aged  $\geq 60$  yrs, b) English speaking, c) admitted within the preceded 24 hours and research staff were available to collect all baseline data within the first 24 hours of admission.

Exclusion criteria included: a) unstable congestive heart failure, b) chronic kidney disease stage 5, c) classified as nil by mouth on admission, and d) had an expected length of stay of less than 24 hours.

### **Measures**

The study utilised questionnaire, clinical assessments, audits and observational techniques (Table 1). All baseline data from each participant were collected within 24 hours of admission and exit data were collected prior to discharge or up to day four of admission, which indicated end of study. The measures included:

#### **A. Demographic and participant information**

Demographic information was collected at baseline including living arrangements (e.g., community dwelling with carer, community dwelling without carer, residential care, assisted living), age, gender, co-morbidities, recent vomiting and/or diarrhoea (last three days), fever:  $\geq 37.5^{\circ}\text{C}$  (last three days), self or informant reported change in functional level, environmental risks (e.g., hot weather, recent exercise), medications, alcohol and surgical history.

B. Assessments

1. Frailty measure using the Clinical Frailty Scale (K. Rockwood et al., 2005).
2. Delirium measured by the Confusion Assessment Method (CAM) (S K Inouye et al., 1990).
3. Cognitive status measured by Rowland Universal Dementia Assessment (RUDAS) (Storey, Rowland, Conforti, & Dickson, 2004).
4. Dehydration risk using the Dehydration Risk Appraisal Checklist (J. Mentis & J. Wang, 2011).

The Clinical Frailty Scale was completed for each participant as a measure of frailty or vulnerability, which is a consequence of age-related decline in multiple physiological systems over a person's lifespan and is highly predictive of mortality and other adverse outcomes (Clegg, Young, Iliffe, Rikkert, & Rockwood, 2013). The clinician uses his/her judgement and rates a person's frailty into one of seven categories: (K. Rockwood, 2005).

1. Very fit. Robust, active, energetic, well motivated and fit: these people commonly exercise regularly and are in the most fit group for their age
2. Well. Without active disease, but less fit than people in category 1.
3. Managing well. People whose medical problems are well controlled, but are not regularly active beyond routine walking
4. Vulnerable. While not dependent on others for daily help, often symptoms limit activities.
5. Mildly frail. These people often have more evident slowing, and need help in high order IADLs.
6. Moderately frail. People need help with all outside activities and with keeping house.
7. Severely frail. Completely dependent for personal care.
8. Terminal Ill. Approaching end of life. (K. Rockwood, 2005)

The Confusion Assessment Method (CAM) consists of nine operationalised DSM-III-R criteria with a diagnostic algorithm based on the four essential criteria of: 1) acute onset and fluctuating course; 2) inattention; 3) disorganised thought processes and 4) altered level of consciousness. A positive diagnosis of delirium is made if the person has feature 1 and 2 plus either 3 or 4 (S K Inouye et al., 1990). The CAM requires only 5-10 minutes to administer and has shown very high sensitivity (94-100%), and specificity (89-95%) for detecting delirium as well as high inter-rater reliability (0.81–1.00)(Wei, Fearing, Sternberg, & Inouye, 2008).

The Rowland Universal Dementia Assessment (RUDAS) is a brief cognitive screening instrument designed to minimise the effects of cultural learning and language diversity on cognitive performance (Storey et al., 2004). The RUDAS yields scores of between 0-30 with higher scores indicative of better cognitive functioning. It is psychometrically sound with demonstrated high sensitivity (89%) and specificity (98%) for identifying cognitive impairment (Storey, J.E. et al., 2004).

The Dehydration Risk Appraisal Checklist is a 31-item checklist including personal characteristics, medical conditions, medications, laboratory abnormalities and clinical characteristics where information is collected from direct observations and patient medical records. The total number of risk factors identified is totalled and the greater the number of risk factors, the higher the risk of hydration problems (Janet. Menten). Knowledge of risk factors is important as it will increase awareness of those who are the most vulnerable to dehydration and consequently efforts to improve the hydration status of patients can have a more targeted approach (Wakefield, Menten, Holman, & Culp, 2009).

### C. Clinical Assessment

Clinical assessments included: Lying and standing blood pressure (see note for clarification), pulse rate, temperature, visual assessment of jugular venous

pressure (JVP), tissue turgor (assessing pinching the skin at the dorsum of the hand and over the manubrium, normal tissue turgor indicated by disappearance of the skin fold in  $\leq 2$  seconds), self-reported thirst, inspection of oral mucous membranes for dryness, inspection of tongue for dryness and longitudinal furrows and reported urine specific gravity and urine ketones. These assessments have previously been validated as practical and reliable indicators of dehydration in older hospital patients (Vivanti, Harvey, Ash & Battistutta, 2008).

Note: A sustained drop in systolic blood pressure of at least 20mmHg or diastolic blood pressure of 10mmHg within three minutes of standing is considered orthostatic hypotension (Freeman et al., 2011). Hypovolaemia is one recognised cause of orthostatic hypotension (Bradley & Davis, 2003).

#### D. Hydration status

Clinical dehydration cannot be defined by one symptom, sign or laboratory result. Consequently, we have used a number of measures to objectively assess the hydration status of participants including pathology, ward urinalysis, clinical examination and patient reports. The clinical assessments details are outlined in the prior section.

The pathology included: ward test of urine for ketones and specific gravity (SG), serum sodium, serum urea/creatinine ratio and, serum and urine osmolality. For the purposes of this study we are referring to dehydration as a depletion in total body water as a result of pathological fluid losses, diminished water intake, or a combination of both (Armstrong, Johnson, McKenzie, & Muñoz, 2013).

Water loss is associated with elevated serum and urine osmolality. However, when both water and salt is lost, dehydration is associated with hyponatraemia and low osmolality. A serum sodium above 145mmol/Litre (mmol/L) was considered to potentially represent intravascular volume depletion (Reed, Zimmerman, Sloane, Williams, & Boustani, 2005). Osmolality was considered to be elevated when it was greater than 300 mmol/L. Impending water-loss

dehydration is suggested when serum osmolality is between 295 – 300mmol/L (Hooper et al., 2012). An impending dehydration is associated with a reduction of 3% - 5% of body weight within seven days and current dehydration corresponding to changes of more than 5% of body weight (Hooper, Bunn, Jimoh, & Fairweather-Tait, 2014).

Table 1. Data collection information

CONCEPT	MEASURE	COMPLETION TIMES
Participant characteristics	Questionnaire. BP, HR, Temperature	Baseline
Observational/audit data	Room and care plan & chart audits	Once during admission
Frailty measure	Clinical Frailty Scale	Baseline+* end
Cognitive status	Rowland Universal Dementia Assessment Scale	Baseline+* end
Weight		Baseline+* end
Delirium	Confusion Assessment Method	Baseline+* end
Dehydration risk	Dehydration Risk Assessment	Baseline
Hydration status	Clinical assessment + pathology	Baseline+*end
Meal time assessments	Breakfast, lunch and dinner observations	During admission X 1 each meal
<i>*end refers to prior to discharge or exit from study (maximum on day 4 following admission)</i>		

E. Observational/audit data

Observational data were collected throughout the first four days of each patient’s admission, and audits of rooms and care plans were conducted by two experienced gerontological nurses (JMc, MM), as unobtrusively as possible. As no validated tools were identified as suitable, the observational and audit tools were developed by the researchers based upon their extensive experience of working with geriatric inpatients and evidence from the literature, in particular the Hydration Management guideline developed by Menten (J. C. Menten & Kang, 2011). While these tools were not formally assessed for validity and reliability, preliminary field testing was undertaken to assess their face validity

and practicality by one of the study investigators (JMc), prior to study commencement

### **Ethical Considerations**

The project was approved by the Human Research and Ethics committee within The Prince Charles Hospital and Queensland University of Technology. Written consent of all participants and/or legally appointed representatives or proxies was obtained prior to participation. The decision about the person's capacity to consent to participate in the study was made by the trained RA in consultation with the nurse unit managers, medical team members and the family. All patients were involved (where possible) in the consenting process however, if deemed to be unable to give informed signed consent the person responsible (usually a family member) was asked to provide the written consent.

Some study participants may have been under the direct care of Dr. Harvey or Dr. Eeles (members of the research team) but these Doctors were not involved in the recruitment process thereby eliminating any appearance of coercion. If dehydration was suspected following clinical assessments hospital staff were informed.

### **Study Procedure**

Because of work commitments of the study team and inability to undertake exit data collection on weekends, recruitment was restricted to between Sunday afternoon and Tuesday evenings. The study commenced in July, 2013 and finished in November, 2014.

Initial screening for eligibility occurred through staff report; to identify patients who met the inclusion criteria. For patients meeting the inclusion criteria the RA met with the patient (and his/her proxy for cognitively impaired sample) to explain the study and answer questions so that they had opportunities to express willingness to be part of the study. Information about the project was provided in a manner that was easy for people with cognitive impairment to understand. The RAs had a minimum of 5 hours training depending on the data

they collected. Two of the research team, MM & JM had extensive previous experience in using the data assessment tools. The medical officers undertaking the clinical assessments both had in excess of ten years clinical experience in acute care of older people both with and without cognitive impairment.

Following consent, baseline data, including chart review was collected by a trained RA. Where possible blood testing was added to blood samples collected as part of the normal admission or hospitalisation process. Urine samples were collected specifically for study purposes. Blood pressures, Pulse rates, temperatures, weights and heights were undertaken by the RA. Blood pressure measurements, when able, were measured firstly with the participant lying in bed and then following he or she being in an upright position for at least two minutes. Other assessments including frailty, delirium and cognition measures were undertaken by a member of the research team. Clinical assessments were undertaken by one of two experienced medical officers within 24 hours of the participants admission to hospital. Cognitive impairment was defined as a RUDAS score of 22 or less [unless the low score was a consequence of another disability such as vision impairment (n = 2)], while those with RUDAS scores  $\geq 23$  were considered to be cognitively intact.

Audits of rooms, care plans and medical records were undertaken (observational data and chart review) following recruitment by members of the research team. One breakfast, lunch and dinner mealtime observation was done during the participants hospital admission. Data were collected again at the end of hospitalisation or on day four of admission (whichever occurred first) as per Table 1.

## **Data Analysis**

Prior to data collection a data coding manual was developed that provided descriptions of each variable and response codes. Information collected was entered into a data base, by a member of the research team, that was stored on a secure hospital network drive. Missing values were labeled as 999 and not applicable as 888 within the database. Data were entered into an Excel database and then transferred into the Statistical Package for the Social Sciences (SPSS) for analytic purposes.

Patients with dementia, delirium and delirium superimposed on dementia categories were grouped into one cognitive impairment (CI) group.

Serum osmolality results were coded into:

1. normal = <295mmol/L,
2. impending waterloss dehydration = 295 – 300 mmol/L
3. potential dehydration = >300 mmol/L.

Weight loss from admission to exit from study was recoded into a new variable with:

- 0 = not greater than 3% weight loss
- 1 = equal to or greater than 3% weight loss

Clinical Frailty Scale results were recoded into a new dichotomous variable where:

- Fit = vulnerable, managing well, well and very fit
- Frail = mildly frail, moderately frail and severely frail

To ensure accuracy of data, frequency distributions and descriptive statistics were produced for all variables and outliers examined and corrected where appropriate. Once the data was cleaned descriptive data analyses were undertaken to examine distributions and simple relationships between different variables. To examine the continuous variables frequency distributions, Means (M), and standard deviations (SD) were utilised. To examine categorical or



dichotomous variables, count and percentages were employed (Kirkwood & Sterne, 2007).

Following baseline descriptive analysis the sample was divided into two groups. Group one represented participants without cognitive impairment and group two were participants with cognitive impairment which included people living with dementia, people with delirium and those with delirium superimposed on a dementia. Bi-variate analysis was performed to compare baseline characteristics of the group. Additionally, outcome variable comparisons were undertaken between the two groups using independent two-sample *t*-test analyses to compare means and Chi-square or Fisher's exact test to compare categorical variables between the participants in the two groups. Observational data are presented as descriptive data (text, percentages, means and SDs), while Chi-square tests were used to compare important patient characteristics according to CI status (CI versus no CI), and nursing actions according to dehydration status at admission (dehydrated versus euhydrated).

Multivariate logistic regression analyses were performed, using the Forward Likelihood Ratio entry method, to identify independent variables associated with dehydration at admission and study exit [dehydration was defined using combined measures (clinical assessment OR serum osmolality readings) in both instances]. Variables assessed as possible predictors included age, gender, cognitive status (CI versus no CI), RUDAS scores, Clinical Frailty Scale scores, dichotomized Clinical Frailty Scale Scores (fit versus frail; fit included scores 1-4; frail included scores 3-6), Body Mass Index (BMI), number of comorbidities, DRAC sub-scale and total scores, administration of IV fluids (yes, no), and psychotropic medication use (yes/no). Dehydration at admission was also assessed as a potential predictor of dehydration at exit.

### **Assessment of diagnostic accuracy**

Measures of sensitivity, specificity, positive (PPV) and negative predictive values (NPV), and receiver operating curves (ROC) were calculated to evaluate the accuracy of clinically assessed dehydration in predicting dehydration diagnosed by serum-calculated osmolality (CO), at admission and study exit.

Participants were categorized as either euhydrated (having normal body water content) or dehydrated, on each occasion, using both methods. Patients were considered dehydrated, according to the CO method if they had a CO reading  $\geq 295$  mmol/L. Hence, this definition included both impending water loss dehydration (CO: 295-300 mmol/L) and current dehydration (CO:  $> 300$  mmol/L). Levels of inter-rater agreement (poor agreement:  $\kappa < 0.2$ ; fair agreement:  $\kappa = 0.20 - 0.40$ ), as defined by Altman were used to rate strength of agreement (Altman, 1991).

All data analyses were performed using SPSS version 22.0 with a level of significance (p-value) set at 0.05.

### **Outcome Measures**

The primary outcome measures for this study were:

- 1) hydration status and
- 2) identified barriers and enablers.

To understand the hydration status of each individual participant various key indicators were used including:

- a. clinical assessments including changes in blood pressure from lying to standing/sitting positions.
- b. serum and urine osmolarity measures
- c. serum and urine sodium measures

## SECTION 4. Results

Recruitment for this study occurred from July 2013 until the end of November, 2014. A total of 69 patients, who were admitted to the Internal Medical Services of the participating hospital, were approached to participate in the study. Of these, 29 patients with cognitive impairment and 17 patients without cognitive impairment agreed to participate. This number represented a response rate of 67%. Reasons for refusal were varied and included, the patient feeling “*too tired*” or “*too unwell*”, family not willing to provide consent as they didn’t want their relative “*bothered with anything else*” and “not interested”. Cognitive impairment was defined as a RUDAS score of 22 or less [unless as a result of a disability such as vision impairment ( $n = 2$ )].

One participant was consequently excluded because of not fulfilling the inclusion criteria (no data collected) and one participant was withdrawn from the study, soon after consenting (some baseline data collected), because of an acute deterioration in medical status leaving a final sample of 44 participants included in the final analysis.

### Baseline Characteristics of the sample

Baseline data was collected and analysed from 44 participants. Participants were either cognitively intact (non-CI) ( $n=17$ ), or had cognitive impairment (CI). Results from the cognitive assessments (RUDAS, CAM) together with collateral information from the patients’ medical charts indicated that 20 patients had probable dementia, two had delirium and four had delirium superimposed on dementia (Figure 1). One participant developed delirium soon after admission to the study (CI-DSD). The majority were female ( $n=24$ , 55%) and the average age was 81 years ( $SD$  8.5). In total 93% ( $n=41$ ) of the sample lived in a house or unit with or without a carer and the remaining 7% ( $n=3$ ) were admitted from a residential aged care facility.

### RUDAS

Five participants couldn't have their cognition formally assessed because of severe cognitive impairment and two because of visual impairments. Of the remaining 37 participants the median score on the RUDAS was 21 with scores

ranging from 9 - 29 (Figure 2). The average number of co-morbidities for each participant was 2 ( $SD = 1.2$ ) with a range from 0 - 6.

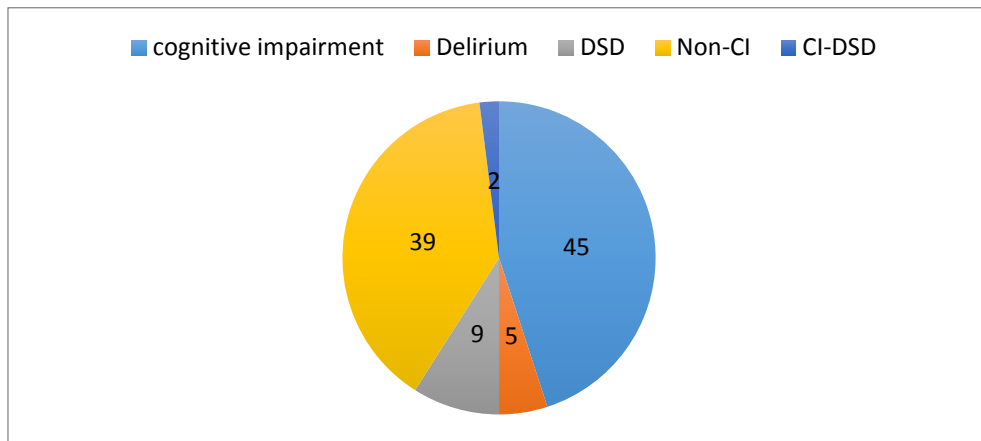


Figure 1. Percentage of participants in each group at baseline (n=44)

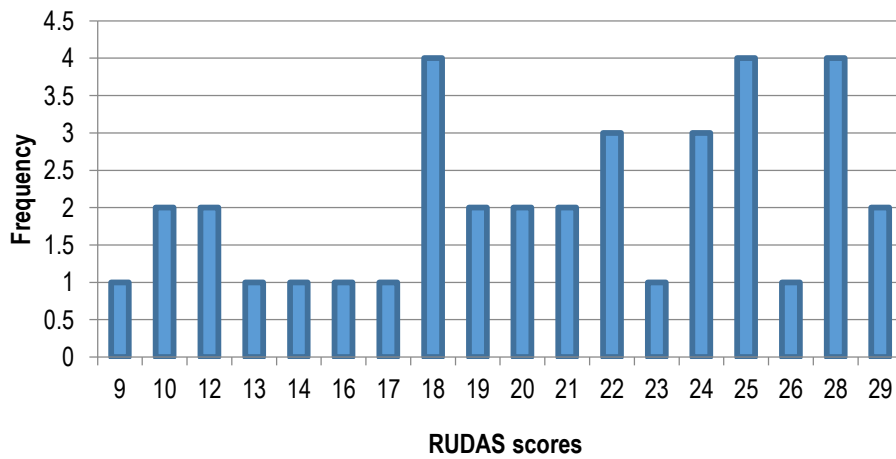


Figure 2. RUDAS scores of participants (n=37)

### Frailty

The majority of the participants were classified as “mildly” to “moderately frail” (52%;  $n=23$ ) and 32% ( $n=14$ ) classified as “well” or “managing well”. In total 7% ( $n=3$ ) of the participants were classified as vulnerable and 9% ( $n=4$ ) were severely frail (Figure 3).

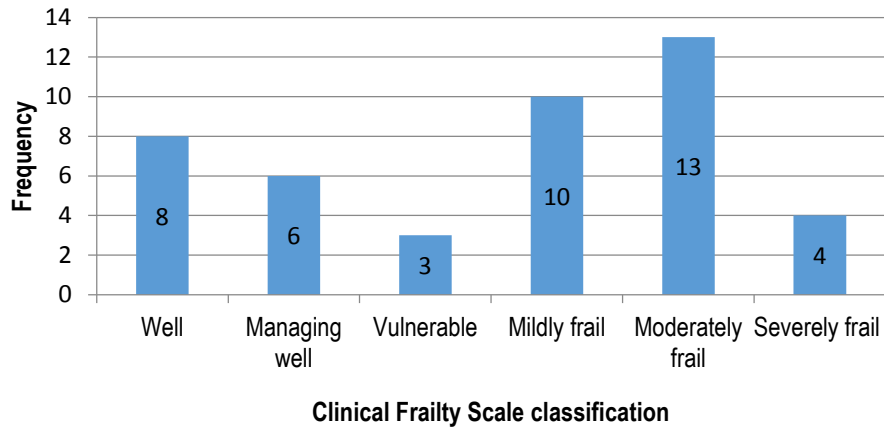


Figure 3. Assessed Frailty classifications for all participants ( $n=44$ )

Figure 4 illustrates the percentages of participants within each Clinical Frailty Scale classification across the non-CI and CI groups.

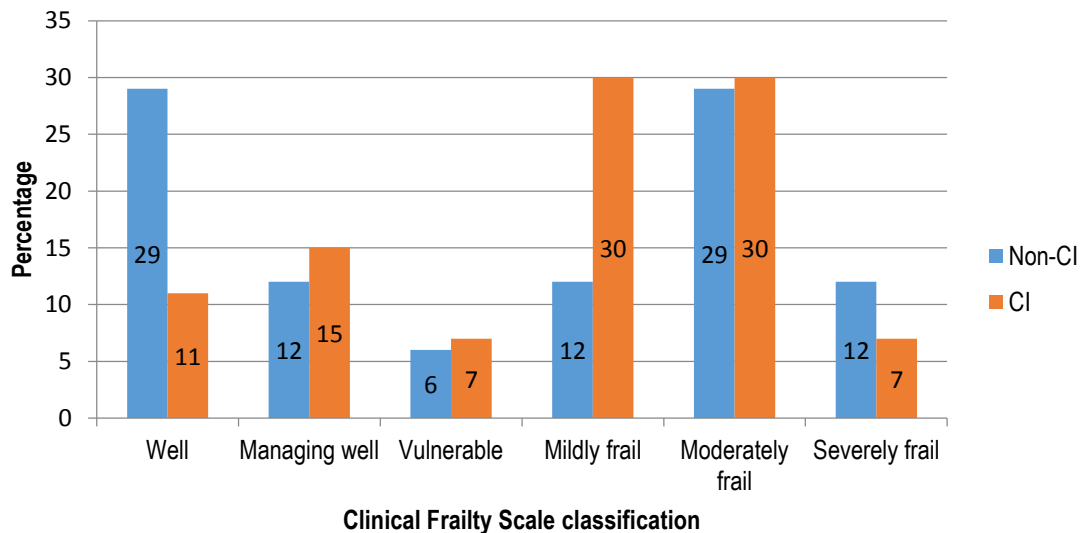


Figure 4. Clinical Frailty Scale classification for participants in the CI and Non-CI groups

Recoding of these frailty elements into a dichotomous variable of “fit” and “frail” showed that 39% ( $n=17$ ) of the participants were fit and the remaining 61% ( $n=27$ ) frail. In total 67% ( $n=18$ ) of participants from the CI group and 53% ( $n=9$ ) of participants from the non-CI group were “frail” (Figure 5).

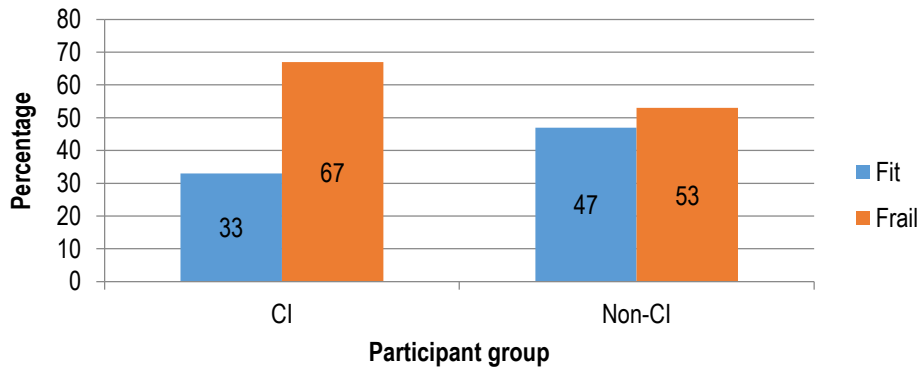


Figure 5. Percentage of participants from the CI and Non-CI groups who were either "fit" or "frail" ( $n=44$ )

Results showed that all the participants in the delirium superimposed on dementia group ( $n=4$ ); 50% ( $n=1$ ) from the delirium group, 60% ( $n=12$ ) from the cognitive impairment-non delirium group; 53% ( $n=9$ ) from the non-cognitively impaired group, and all ( $n=1$ ) from the CI-DSD group, were classified as “frail” (Figure 5).

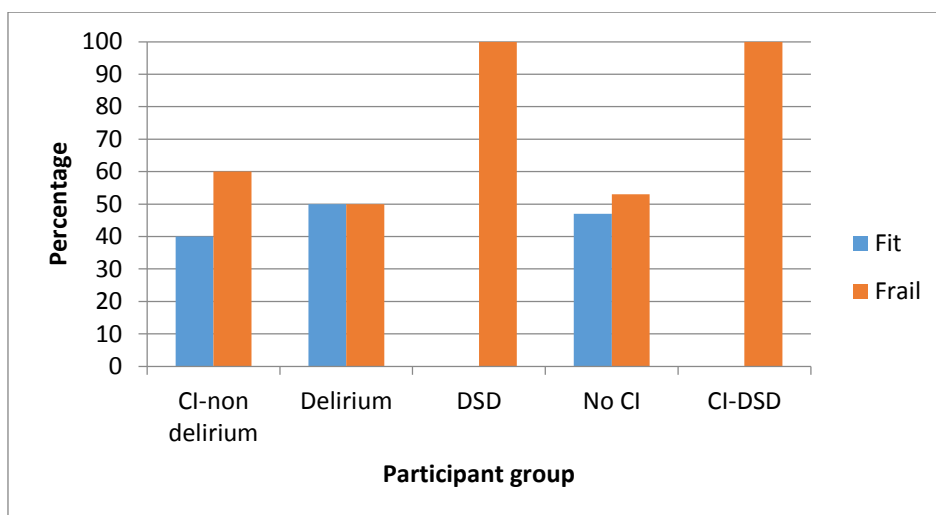


Figure 6. Percentage of participants from each group who were either "fit" or "frail" ( $n=44$ )

## Alcohol intake

Of the participants who stated that they drank alcohol ( $n=17$ ) the median number of standard alcoholic drinks consumed each week were 5 with a minimum of 0.35 and a maximum of 49 self-reported standard alcoholic drinks consumed each week.

## Other Baseline Characteristics

Other baseline information collected via self or informant -based reports or via chart audits are displayed in Table 2.

**Table 2. Other Baseline Characteristics & Data**

Variable	Number (percentage)
*Psychotropics at baseline	10 (23)
A change in functional status over the preceding month	26 (59)
Vomiting over the preceding three days	9 (21)
Diarrhoea over the preceding three days	5 (11)
Fever > 37.5°C in preceding three days	9 (21)
Hot weather in the preceding three days (greater than 25°C)	15 (34)
Active exercising in the preceding three days (including mowing and strenuous ADLs)	10 (23)
Self-reported depression	19 (44)
Usually on texture modified fluids	1 (2)
Impaired physical ability to initiate drinking unaided	5 (11)
Impaired language	4 (9)
Impaired motor planning	3 (7)
ADL feeding	
• independent with eating	34 (77)
• partially dependent	3 (7)
• supervised set-up	6 (14)
• total assistance	1 (2)
ADL walking	
• completely independent	17 (39)
• independent with assistive device	13 (30)
• required assistive person	3 (6)
• requires person and device	10 (23)
• dependent	1 (2)

\* South Australian Government, 2012, Psychotropic drug list

The risk of dehydration measured by the Dehydration Risk Assessment showed that the average number of risks were 6 ( $SD = 3.12$ ) range 0 - 14. The greater number of characteristics present for a participant indicated a greater risk of dehydration (Table 3).

**Table 3. Dehydration risk appraisal: Average number of risk items per category (n=40)**

Category	Number of items in this category	M (SD)
A: Person characteristics	3	1.2 (1)
B: Significant Health Conditions	16	2.2 (1.5)
C: Medications	6	1.4 (1)
D: Intake	12	.7 (.9)
E: Biochemical characteristics	6	.4 (.7)

**Baseline comparisons of participants without cognitive impairment (non-CI) and those with cognitive impairments (CI)**

Independent t-test results showed that there were no statistical differences in ages of participants between the non-CI ( $M = 80$ ,  $SD = 9.8$ ) and the CI groups ( $82$ ,  $SD = 7.7$ ),  $t(42) = -0.53$ ,  $p = .6$ . However, as to be expected, the RUDAS cognitive assessments scores for participants in the CI group ( $M = 15$ ,  $SD = 6.3$ ) were significantly lower than those is the non-CI group ( $M = 25.6$ ,  $SD = 2.4$ ),  $t(40) = -6.6$ ,  $p = <0.001$ . There were no significant differences in the standard alcoholic drinks consumed by the non-CI group ( $M = 17$ ,  $SD = 19.8$ ) compared to the CI group ( $M = 10.5$ ,  $SD = 13.5$ )  $t(15) = .78$ ,  $p = 0.45$ .

The CI group had significantly more co-morbidities ( $M = 2.3$ ,  $SD = 1.2$ ) than the non-CI group ( $M = 1.4$ ,  $SD = 1$ )  $t(42) = 2.30$ ,  $p = 0.03$ . The CI group also had more dehydration risks ( $M = 5.9$ ,  $SD = 2.9$ ) at baseline than the non-CI group ( $M = 4.1$ ,  $SD = 2.7$ )  $t(43) = 2.6$ ,  $p = 0.05$ . However, given the CI group scored 1 for having CI a further comparison, removing this extra risk from the CI group, indicated that there were still significant differences in numbers of dehydration



risks for those in the CI group compared to those in the non-CI group  $t(42) = 2.0, p=0.04$ . The Clinical Frailty Scale was recoded into combined variables of “fit” and “frail” variables because of the small numbers of participants in some Clinical Frailty Scale categories. To examine the hypothesis that there was an association between the CI and non-CI participants and being either “fit” or “frail”, a chi-square test of independence was performed. This hypothesis was rejected because results indicated that there were no statistically significant relationships between these variables,  $\chi^2(1, n=44) = .83, p=0.36$ . We were unable to examine relationships between frailty reclassifications and the four cognitive groups of dementia, delirium, DSD and non-CI because of small numbers. Other baseline comparisons are displayed in Table 4.

**Table 4. Baseline comparisons between non-CI and CI groups**

Characteristic	Non-cognitive impairment group (n=17)	Cognitive impairment group (n=27)	p
Gender n			
Male	8	12	0.8
Female	9	15	6
Living arrangements			
RACF	1	2	
House/Unit	10	16	
House/Unit with carer	6	8	.94
*Psychotropics at baseline	1	9	.03
A change in functional status over the preceding month	10	16	1.0
Vomiting over the preceding three days	4	5	.72
Diarrhoea over the preceding three days	2	3	1.0
Fever > 37.5°C in preceding three days	3	6	1.0
Hot weather in the preceding three days (> 25°C)	5	10	.75
Active exercising in the preceding three days (including mowing and strenuous ADLs)	7	3	.03
Self-reported depression	9	10	.53
Usually on texture modified fluids	0	1	1.0
Impaired physical ability to initiate drinking unaided	2	3	1.0
Impaired language	0	4	.15
Impaired motor planning	1	2	1.0
ADL feeding			
• independent with eating	16	18	
• partially dependent	1	2	
• supervised set-up	0	6	
• total assistance	0	1	.14
ADL walking			
• completely independent	0	1	
• independent with assistive device	3	7	
• required assistive person	0	3	
• requires person and device	5	8	
• dependent	9	8	.37

\* South Australian Government, 2012, Psychotropic drug list

## Biochemical results

Ward-based urinalysis testing revealed 10% ( $n=4$ ) participants showed ketones at baseline and 16% ( $n=5$ ) had ketones in their urine at exit from study. Specific Gravity (SG) of these urine samples ranged from 1005 – 1030 with 8% ( $n = 3$ ) at baseline and 6% ( $n = 2$ ) at study exit having a SG >1020.

Paired-samples t-tests were conducted to compare urine and serum biochemical results in the total sample at baseline and exit from study. There were no statistically significant differences in serum osmolality, urea/creatinine ratios, urine osmolality and urine sodium results from baseline to exit from study in this sample (Table 5). Results indicated a significant increase in participant's serum sodium levels from baseline ( $M = 133$ ,  $SD = 5.7$ ) to exit from study ( $M = 136$ ,  $SD = 3.6$ ,  $t(33) = -2.9$ ,  $p = 0.007$ ).

**Table 5. Paired t-test results from baseline to exit from study for total sample**

	<i>n</i>	Mean diff.	SD	<i>t</i>	<i>p</i>
Serum (baseline to exit)					
Osmolality (mmol/L)	26	-3.3	9.4	-1.8	.088
Sodium (mmol/L)	33	-2.5	4.9	-2.9	.007
Urine (baseline to exit)					
Osmolality (mmol/L)	30	35	173	1.1	.275
Sodium (mmol/L)	29	-7.4	47	-.9	.398

Paired-sample t-tests were conducted to compare urine and serum biochemical results in both the Non-CI and the CI groups at baseline and exit from the study. No significant differences were found in participants from the non-CI group. However, significant differences were found for participants in the CI group, for serum sodium levels from baseline ( $M = 134$ ,  $SD = 4.3$ ) to exit ( $M = 136$ ,  $SD = 3.7$ ,  $t(19) = -.69$ ,  $p = 0.029$ ). The reference range for urea/creatinine ratios was 40 – 100 and serum sodium was 135 – 145mmol/L.

## Question 1 and 2: Hydration status

This section provides the results of the hydration markers utilised in this study.

### Clinical assessment for hydration status

Of the participants assessed by the medical officers for dehydration at baseline ( $n=41$ ) and exit from study ( $n=32$ ) a total of 11 (27%) and 6 (19%) respectively were thought to be dehydrated. A chi-square test was performed and no relationship was found between participants in the CI group compared to the non-CI group, and clinical hydration status assessments ( $\chi^2(1, n = 41) = 0.51$   $p = 0.48$ ) at baseline or exit from study ( $\chi^2(1, n=32) = 0.27$   $p = 0.60$ ) (Table 6).

**Table 6. Dehydration category via clinical assessment in the non-CI and CI groups**

Time point	Hydration variable	Non-CI (%)	CI (%)	Total (%)
<b>Baseline</b> ( $n = 41$ )	Potential dehydration	5 (33)	6 (23)	11(27)
	No dehydration	10 (67)	20 (77)	30(73)
<b>Exit from study</b> ( $n = 32$ )	Potential dehydration	3 (23)	3 (16)	6(19)
	No dehydration	10 (77)	16 (84)	26(81)

Of the 11 participants who were assessed as potential dehydration via clinical assessment at baseline one participant in the CI group and all three participants in the non-CI group were assessed as potential dehydration at exit from the study. Consequently, there were two new participants from the CI group and none from the non-CI group who developed clinical signs of dehydration following admission to hospital. In addition, two participants from the CI group who were assessed as potential dehydration at baseline had no exit from study results.

### Weight loss > 3%

The average weight of participants at baseline was 71.4kgs ( $n=44$ ) and 72.6kgs ( $n=39$ ) at exit from the study. The average weight difference from baseline to exit was 100gms (range -3600gms to 6600gms). Results from independent t-tests indicated that there was no difference in weight between participants in the

CI group compared to those in the non-CI group at baseline ( $t(42) = .82$ ,  $p = 0.4$ ), exit from study ( $t(37) = 1.6$ ,  $p = 0.12$ ) or in overall weight differences ( $t(39) = .46$ ,  $p = 0.65$ ).

Percentage weight loss calculations indicated that five participants had greater than 3% weight loss from baseline to exit from the study ( $n = 41$ ,  $M = 0.06$ ,  $SD = 2.4$ ). This recent weight loss may be considered to be a potential indicator for dehydration (Schols, De Groot, Van Der Cammen, & Rikkert, 2009). Two of these participants were from the non-CI group and three from the non-CI group. Independent t-test results indicated that the recent weight loss for participants in the non-CI group ( $M = 0.19$ ,  $SD = 2.5$ ) was not significantly different from those in the CI group ( $M = -0.02$ ,  $SD = 2.5$ ,  $t(39) = 0.25$ ,  $p = 0.80$ ).

### Serum Osmolalities measures for hydration status

At baseline, 82% ( $n = 33$ ) of the sample had serum osmolalities considered to be at normal levels, 11% ( $n = 5$ ) had serum osmolalities considered to have impending dehydration and 7% ( $n = 3$ ) of the sample had serum osmolalities considered to be indicative of dehydration (Figure 7).

By comparison, at exit from study, 84% ( $n = 26$ ) of the sample had serum osmolalities considered to be at normal levels, 6% ( $n = 2$ ) had serum osmolalities considered to have impending dehydration and 10% ( $n = 3$ ) of the sample had serum osmolalities considered to be indicative of dehydration (Figure 4). There were some missing data from each time point.

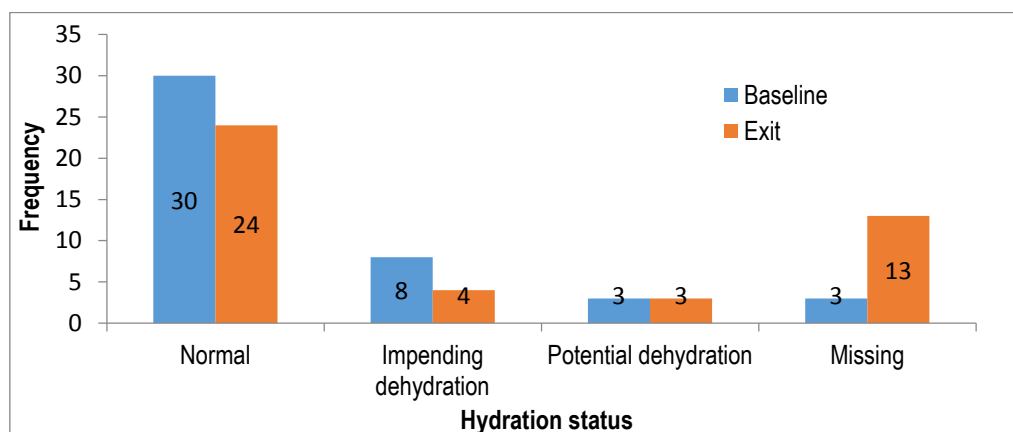


Figure 7. Participants hydration status via serum osmolality

A paired-sample t-test was conducted to compare participant’s serum osmolality results at baseline to results at exit from the study. There was no statistically significant difference in serum osmolality, from baseline (M = 284, SD = 14.5) to exit from study (M = 288, SD = 9.5) in this sample;  $t(29) = -1.59$ ,  $p = 0.12$ . When analyzing results from the participants in the CI group there was no statistically significant difference in individual serum osmolality results, from baseline (M = 284, SD = 12.5) to exit from study (M = 287, SD = 10.7);  $t(18) = -1.10$ ,  $p=0.29$ . Similarly, analysis of results from participants in the non-CI group found no statistically significant difference in serum osmolality results, from baseline (M = 285, SD = 18.1) to exit from study (M = 290, SD = 7.4);  $t(11) = -1.05$ ,  $p=0.30$ .

Results from the serum osmolality categorization of normal, impending dehydration and potential dehydration showed no statistically significant differences between the CI group and the non-CI group at baseline ( $\chi^2(2, n= 41) = .09$   $p = 0.96$ ) and exit from study ( $\chi^2(2, n=31) = 0.15$   $p = 0.93$ ) (Table 7).

**Table 7. Dehydration category via baseline and exit serum osmolality in the CI and non-CI groups**

Time point	Hydration variable	Non-CI (%)	CI (%)	Total
Baseline	Normal	11(33)	22(67)	33
	Impending dehydration	2(40)	3(60)	5
	Potential dehydration	1(33)	2(67)	3
Exit from study	Normal	19(38)	16(62)	26
	Impending dehydration	1(50)	1(50)	4
	Potential dehydration	1(3)	2(67)	3

### **Serum Sodium measures for potential dehydration**

No participants had a serum sodium above 145mmol/L, which was considered to potentially represent intravascular volume depletion, at baseline or exit from study.

**Comparisons between clinically assessed dehydration and serum osmolality (categories)**

As displayed in Table 8 there were seven participants at baseline who were considered to be dehydrated by clinical assessment but not via serum osmolality results and one participant whose serum osmolality indicated potential dehydration but the clinical assessment indicated that there was no dehydration evident. However, these differences were not statistically significant ( $\chi^2(2, N = 39) = 2.4 p = 0.31$ ).

**Table 8. Comparisons between clinical assessments and serum osmolality hydration categories at baseline (n=39)**

Serum Osmolality hydration status via categories	Clinically assessed hydration status	
	Not Dehydrated (%)	Dehydrated (%)
Normal (%)	21 (75)	7 (25)
Impending dehydration (%)	6 (75)	2 (25)
Potential dehydration (%)	1 (33)	2 (67)

At exit from study, four participants were considered to be dehydrated by clinical assessment but not by serum osmolality results and three participants whose serum osmolality indicated potential dehydration but not via clinical assessment (Table 9). Similarly, to baseline results these findings were not statistically significant ( $\chi^2(2, N = 28) = .81 p = 0.67$ ).

**Table 9. Comparisons between clinical assessments and serum osmolality hydration categories at exit (n=28)**

Serum Osmolality hydration status via categories	Clinically assessed hydration status	
	Not Dehydrated (%)	Dehydrated (%)
Normal (%)	17 (81)	4 (19)
Impending dehydration (%)	3 (75)	1 (25)
Potential dehydration (%)	3 (100)	0

**Positive identification of potential dehydrations by combined serum osmolality or clinical assessment, dehydration markers**

In the absence of a “gold standard” for assessment of dehydration, it could be argued that the absence of any of the markers analysed in the previous section, would be consistent with a state of hydration. Conversely, the presence of one or more of these markers it could be deemed that the participant has potential dehydration. Consequently, we have analysed our results accordingly. That is, a positive clinical assessment for potential dehydration and/or a serum osmolality > 300 mmol/L was coded as potential dehydration and absence of any of these coded as not dehydrated. We chose not to include weight loss > 3% as we were uncertain if the weight loss was specifically related to the fluid status of the patient.

Of all participants, 12 (27%) were potentially dehydrated at baseline and 9 (21%) at exit from the study. In total 29% ( $n=5$ ) of the non-CI group and 26% ( $n=7$ ) of the CI group were potentially dehydrated at baseline. A total of 24% ( $n=4$ ) of the non-CI group and 18% ( $n=5$ ) of the CI group had dehydration (according to clinical assessment or serum osmolality readings) at exit from the study. Chi-square tests were performed to examine relationships between the CI and non-CI groups and dehydration (at least one measure) measures at baseline and exit from the study. The relation between these variables was not significant, either at baseline (Fisher’s Exact Test.  $p = 1.00$ ) or study exit (Fisher’s Exact Test.  $p = 1.00$ ).

Table 10 displays the hydration status and hospitalization status at exit from study. At exit from the study one participant from the non-CI group was discharged from hospital despite being assessed as potentially dehydrated by the research team. Additionally, three (11%) participants from the CI group and 1 (6%) from the non-CI group did not have discharge hydration status assessments undertaken by the research team however, they were assessed as potentially dehydrated at baseline. The most common reason for these missing assessments was that the patient was discharged or transferred from the hospital before the research team could undertake the assessments.



**Table 10. Follow up of participants in relation to hydration status and exit from study**

Hydration status at time points	Participant group	
	CI (%)	Non-CI (%)
Dehydrated at entry but not at exit from study	3 (11)	2 (12)
Dehydrated at entry and still dehydrated at exit from study and remained in hospital	1 (4)	2 (12)
Dehydrated at exit from study and remained hospitalized	2 (7)	0
Dehydrated at exit from study and discharged	0	1 (6)
Unknown exit hydration status but dehydrated at entry	3 (11)	1 (6)
No dehydration during study period	17 (63)	9 (53)
Missing	1 (4)	2 (12)
<b>Total</b>	<b>27</b>	<b>17*</b>

\*may not equal 100% because of rounding

### Rehydration in hospital by intravenous fluids

Around one-third of patients ( $n=15$ , 34%) received intravenous (IV) IV fluids while in hospital, although this did not differ according to patient's dehydration status, either at admission [6 patients (50.0%) with dehydration received IV fluids versus 8 (26%) without dehydration] ( $\chi^2=2.3$ ,  $df=1$ ,  $p=0.13$ ), or at discharge [4 patients (44.4%) with dehydration received IV fluids versus 8 (30.0%) without dehydration] ( $\chi^2=0.67$ ,  $df=1$ ,  $p=0.41$ ).

### Comparisons between frailty and hydration status

This section investigates relationships between baseline Clinical Frailty Scale measures, recoded into “fit” or “frail” categories, of the participants and hydration status markers (K. Rockwood, Andrew, & Mitnitski, 2007).

#### Clinical Frailty markers and clinically assessed hydration markers for all participants

In total 21% ( $n=3$ ) of the “fit” participants and 30% ( $n=8$ ) of the “frail” participants were clinically assessed as dehydrated at baseline and this difference was not statistically significant,  $\chi^2(1, n=41) = 0.32 p = 0.72$  (Figure 8).

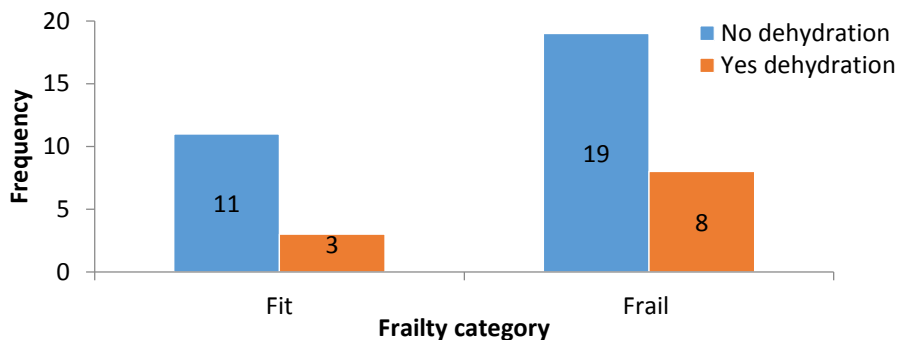


Figure 8. Hydration status of participants in both the "fit" and "frail" categories at baseline ( $n = 41$ )

At exit from the study 9% ( $n=1$ ) of the “fit” participants and 24% ( $n=5$ ) of the “frail” participants were clinically assessed as dehydrated at exit from the study and this difference was not statistically significant  $\chi^2(1, n=32) = 1.03 p = 0.67$  (Figure 9).

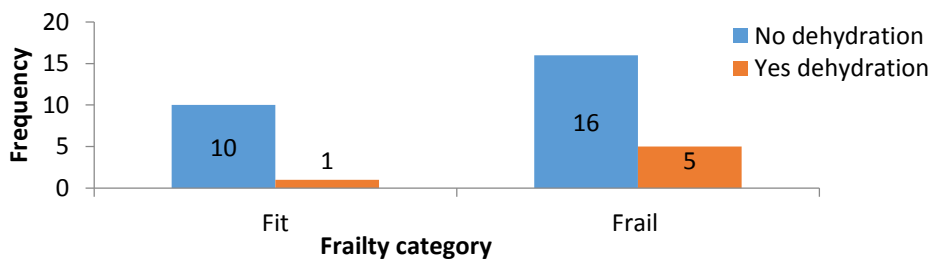


Figure 9. Hydration status of participants in both the "fit" and "frail" categories at exit ( $n = 32$ )

Clinical Frailty markers and clinically assessed hydration markers within cognitive groups

Analysis of results from participants in the CI group found that there was no statistically significant difference in clinical assessed hydration status at baseline between the “fit” and the “frail” participants (Fisher’s Exact Test.  $p = 0.33$ ). However, an association between clinically assessed hydration status and the frailty category was found in the non-CI participants (Fisher’s Exact Test.  $p = 0.04$ ). Results showed that none of the “fit” non-CI participants ( $n=6$ ) had clinically assessed dehydration at baseline. In contrast 56% ( $n=5$ ) “frail” non-CI participants had clinically assessed dehydration at baseline (see Table 11).

**Table 11. Baseline dehydration using clinical assessment and frailty classifications ( $n=41$ )**

CI group	Frailty	Dehydrated (baseline) (clinical assessment)	
		No	Yes
Non-CI	Fit	6	0
	Frail	4	5
CI group	Fit	5	3
	Frail	15	3

There were no statistically significant associations between frailty category and clinically assessed hydration status for either the CI group (Fisher’s Exact Test.  $p = 1.0$ ) or the non-CI group (Fisher’s Exact Test.  $p = 0.23$ ) at exit from the study. However, similar to baseline assessments, none of the “fit” non-CI participants were assessed as dehydrated by clinical assessment markers at exit from the study (see Table 12).

**Table 12. Exit dehydration using clinical assessment and frailty classifications ( $n=32$ )**

CI group	Frailty	Dehydrated (exit) (osmo and/or clinical assessment)	
		No	Yes
Non-CI	Fit	5	0
	Frail	5	3
CI group	Fit	5	1
	Frail	11	2

## Frailty and serum osmolality results

### Clinical Frailty Scale and serum osmolality means

There was not a statistically significant effect of Clinical Frailty Scale results on serum osmolality means for the six frailty categories [F(5,20) = .50,  $p=0.77$ ] at baseline or exit from the study [F(5,13) = 2.3,  $p=0.11$ ].

Similarly, there were no statistically significant results when looking at just the CI group at baseline [F(5,20) = .51,  $p=0.77$ ] and exit from study [F(5,13) = 2.3,  $p=0.11$ ]; or participants from the non-CI group at baseline [F(4,10) = .89,  $p=0.51$ ]. However at exit from study there was a statistically significant difference in mean Osmolality scores between frailty groupings [F(5,6) = 5.0,  $p=0.04$ ]. Despite not being able to do post hoc analysis because at least one group had fewer than two cases Table 13 shows the mean serum osmolality scores within each of the seven frailty categories.

**Table 13. Mean serum osmolality within each frailty category for the non-CI participants**

	Number	Mean serum osmolality
Well	1	289
Managing well	3	286
Vulnerable	1	291
Mildly frail	5	288
Moderately frail	1	308
Severely frail	1	297

### Clinical Frailty Scale and serum osmolality markers

When investigating relationships between Clinical Frailty Scale results and osmolality markers (categories) we were unable to reliably undertake bivariate analysis. Univariate analysis results are displayed in Figures 10 and 11 which illustrate the numbers of participants in each frailty category by serum osmolality marker.

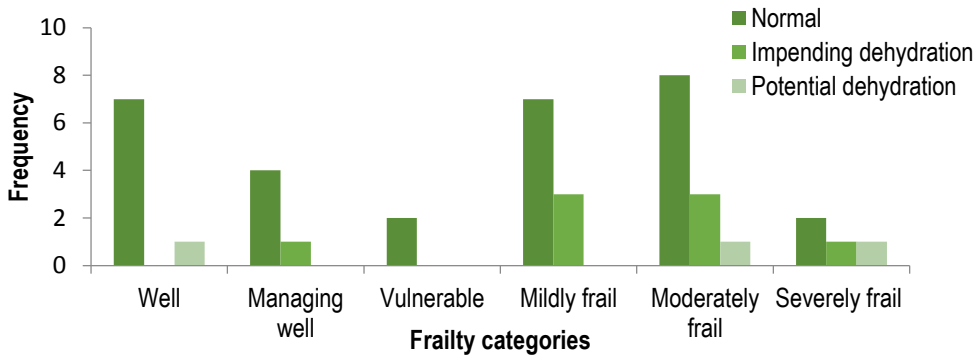


Figure 10. Dehydration Osmolality markers & frailty category at baseline (n=41)

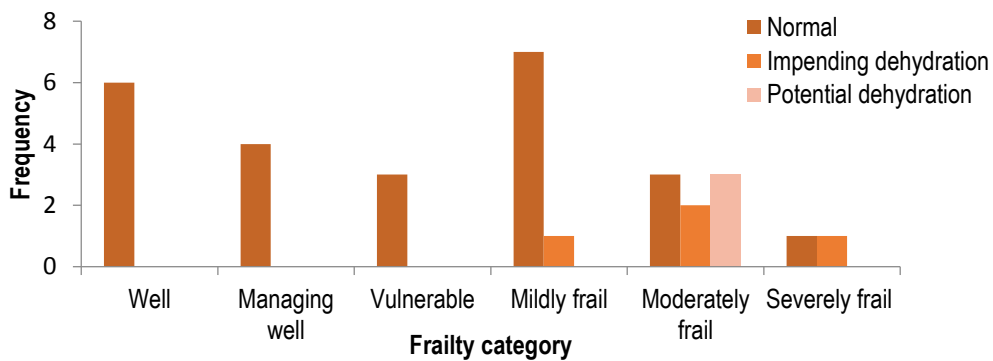


Figure 11. Dehydration Osmolality markers & frailty category at exit from study (n=31)

Fit versus Frailty categories and serum osmolality means

There were no statistically significant differences between baseline osmolality means in the “fit” participants ( $n=15$ ) (Baseline:  $M = 285$ ;  $SD = 11.7$ ) when compared to the “frail” participants ( $n=26$ ) (Baseline:  $M = 285$ ;  $SD = 15.5$ ) as determined by independent sample t-tests at baseline ( $t(39) = -0.07$ ,  $p=0.94$ ) or exit from study ( $t(29) = -1.1$   $p=0.27$ ).

When investigating only participants in the non-CI group there were no statistically significant differences between baseline serum osmolality means in the “fit” participants ( $n=6$ ) (Baseline:  $M = 286$ ;  $SD = 11.5$ ) when compared to the “frail” participants ( $n=9$ ) (Baseline:  $M = 288$ ;  $SD = 18.5$ ) at baseline ( $t(13) = -.21$ ,  $p = 0.84$ ) or exit from study ( $t(7) = -1.2$   $p=0.27$ ).

Similarly there were no statistically significant differences between baseline serum osmolality means in the “fit” CI participants (Baseline:  $M = 285$ ;  $SD =$

12.5) when compared to the “frail” CI participants (Baseline: M = 284; SD = 14.2) at baseline ( $t(24) = .06, p=0.96$ ) or exit from study ( $t(17) = -0.65 p=0.53$ ).

Frailty categories and serum osmolality markers

We were unable to assess associations between the three serum osmolality categories of “normal”, “impending dehydration” and “potential dehydration” and the “fit” and “frail” participant results at baseline or exit from study because of the small or no participant numbers in some categories. The following figures show the distribution of these participant numbers at baseline and exit from the study.

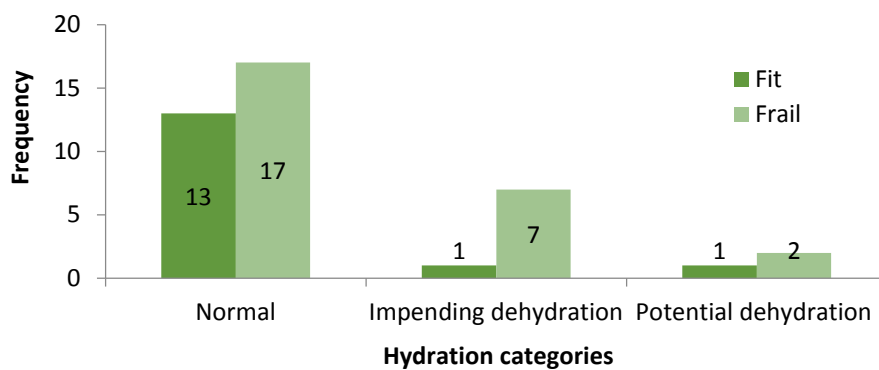


Figure 12. Number of categorized “fit” and “frail” participants within each serum osmolality hydration category at baseline (n = 41)

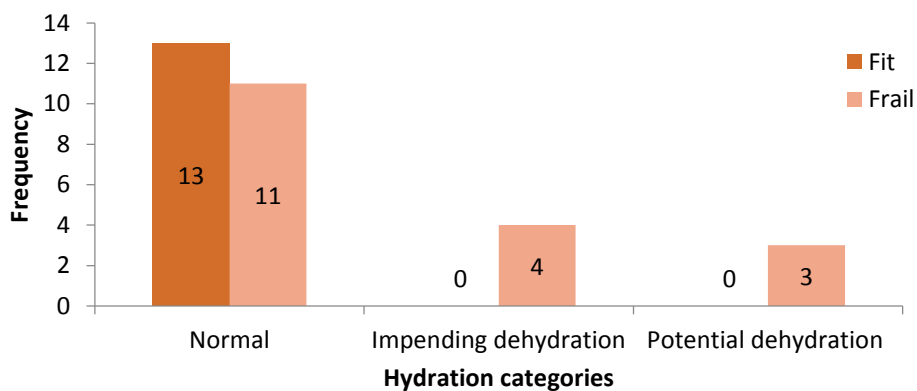


Figure 13. Number of categorized “fit” and “frail” participants within each serum osmolality hydration category at exit from study (n=30)

## Frailty and weight loss

### Clinical Frailty Scale and weight loss means

There were no statistically significant differences between mean weight differences from baseline to exit from study, for participants in each frailty category as determined by one-way ANOVA [ $F(5,35) = 0.74, p=0.60$ ]. Investigations of participants in individual CI groups found that there were no statistically significant differences for either the CI group ( $F(5,20) = 0.83, p = 0.93$ ) or the non-CI group ( $F(5,9) = .57, p=0.72$ ) when investigating mean weight differences for participants in each Clinical Frailty Scale item (table 10).

**Table 14. Mean weight differences for participants within each Clinical Frailty Scale item**

Frailty category	N	Mean difference (SD)
Well	6	-.7kg (1.2)
Managing well	6	.5kg (1.3)
Vulnerable	3	-.8kg (1.2)
Mildly frail	10	.7kg (2.5)
Moderately frail	12	.1kg (1.4)
Severely frail	4	-.3kg (2.2)

### Frailty categories and weight loss means

On average the weight difference for the “fit participants” was a loss of 250gms compared to the “frail” group where there was an average 300gm gain in weight from baseline to exit from study. However, these differences between mean weight differences from baseline to exit from study, for participants in the “fit” category when compared to those in the “frail” category was not statistically significant,  $t(39) = -0.97 p = 0.34$ .

Investigations of participants in individual CI groups found that there were no statistically significant differences for either the CI group  $t(24) = -0.52 p=0.61$  or the non-CI group  $t(13) = -0.94 p=0.36$ ) when investigating mean weight differences for participants in each of the two frailty categories.

### Frailty and combined dehydration markers

#### Clinical Frailty Scale and combined dehydration markers

Because of the small number of participants within each Clinical Frailty Scale it was not possible to investigate relationships between these combined hydration marker results of participants at baseline and exit from study. Numbers of participants rated as potentially dehydrated within each frailty category are displayed in Figure 14 (baseline) and Figure 15 (exit from study).

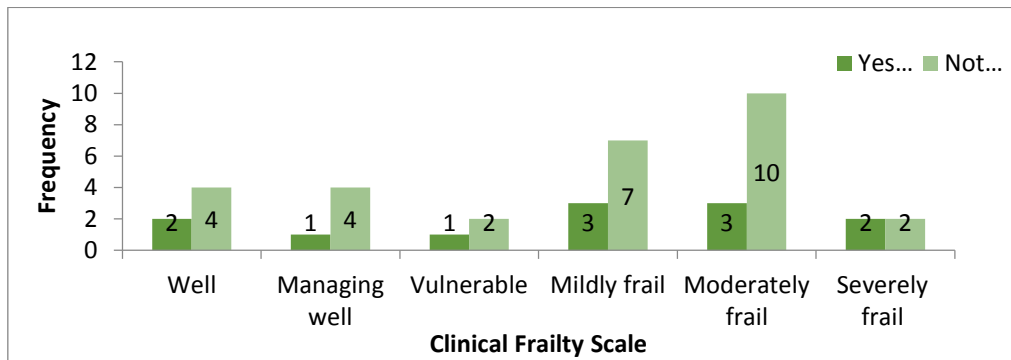


Figure 14. Numbers of participants with or without dehydration (all markers) within each frailty category at baseline (n = 41)

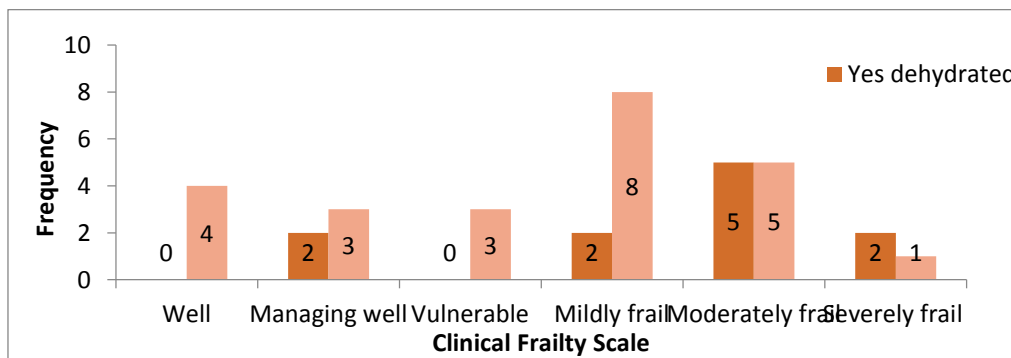


Figure 15. Numbers of participants with or without dehydration (all markers) within each frailty category at exit from study (n = 35)

#### Frailty categories and combined dehydration markers for all participants

In total 25% (n=4) of the participants in the “fit” category and 30% (n=8) of participants in the “frail” category were assessed as “dehydrated” at baseline and this result was not statistically significant,  $\chi^2(1, n=43) = .11 p = 0.74$ . At exit from the study 7% (n=1) of the participants in the “fit” category and 36% (n=8) of participants in the “frail” category were assessed as “dehydrated” and this result was statistically significant,  $\chi^2(1, n = 36) = 3.9 p = 0.048$ .



Frailty categories and combined dehydration markers within cognitive groups

Analysis of results from participants in the CI group found that there was no statistically significant difference in combined dehydration markers between the “fit” and the “frail” participants at baseline (Fisher’s Exact Test.  $p=0.175$ ) or exit from study (Fisher’s Exact Test.  $p=0.611$ ). However, an association between combined dehydration markers and the frailty category was found in the non-CI group (Fisher’s Exact Test.  $p=0.034$ ) at baseline. Results showed that none of the “fit” non-CI participants ( $n = 7$ ) had any dehydration markers at baseline. In contrast 56% ( $n=5$ ) of the “frail” non-CI participants had at least one dehydration marker at baseline. There were no statistically significant difference in combined dehydration markers between the “fit” and the “frail” participants in the non-CI group at exit from study (Fisher’s Exact Test.  $p = 0.105$ ).

### **Length of stay**

The average length of stay (LOS) for the full sample was 4.7 (SD = 3.5) days and 30 patients (70%) had been discharged by study exit. On average the LOS was 1 day longer for the CI group when compared to the non-CI group however, this difference was not statistically significant ( $t(41) = 1.0, p = 0.32$ ).

### **Discharge destination**

In total 77% ( $n=33$ ) of the sample were discharged home or their usual place of residence and 5% ( $n=2$ ) were discharged to a subacute environment and then discharged to their usual place of residence. However, 7% ( $n=3$ ) were discharged to another health care facility, 2% ( $n = 1$ ) transferred to a RACF, 2% ( $n=1$ ) died in hospital, 2% ( $n=1$ ) remained in subacute care and 5% ( $n=2$ ) were transferred to subacute and then transferred to another healthcare facility. There were no statistically significant differences in discharge destination between the groups ( $\chi^2(6, n=43) = 8.5. p = 0.2$ ).

### **Readmissions/Falls/Pressure injuries/mortality**

A total of 33% ( $n=14$ ) of the sample were readmitted (within 30 days of discharge from acute care) to the acute care environment following discharge from acute care. These numbers include 29% ( $n=5$ ) of the participants in the non-CI group and 35% ( $n=9$ ) in the CI group however the difference was not statistically significant (Fisher's Exact Test.  $p = 1$ ). There was one death of a participant in the non-CI group whilst in the acute care setting. One participant from the CI group sustained a fall whilst in hospital and two (5%) sustained a pressure injury during their stay within the acute care environment.

### **Predictors of Dehydration**

Results of the logistic regression revealed no variable independently predicted dehydration at admission to hospital while dehydration at admission significantly predicted exit dehydration (OR=0.07, 95%CI =0.01-0.51,  $p=0.01$ ).

### **Measures of diagnostic accuracy**

The sensitivity and specificity of clinically assessed dehydration in predicting serum-calculated osmolality defined dehydration at admission was 0.50 and 0.77, respectively (see Table 15). Agreement between the measures was fair ( $\kappa = 0.24$ ) (Altman, 1991), and the area under the receiver operating curve (ROC) was 0.64 (95%CI: 0.41-0.87), reflecting poor accuracy. By comparison, the sensitivity and specificity of clinically assessed dehydration in predicting serum-calculated osmolality defined dehydration at exit was 0.00 and 0.78, respectively. Agreement between the two measures at exit was poor ( $\kappa = -0.22$ ) (Altman, 1991), and the area under the ROC curve was 0.39 (95%CI: 0.18-0.64), indicating the clinical assessment was not useful in predicting serum-calculated osmolality defined dehydration. These results as well as PPVs and NPVs are presented in Table 15.

**Table 15. The diagnostic accuracy of clinician-assessed dehydration in predicting dehydration defined by serum osmolality.**

	Clinician Diagnosis		Serum osmolality		Sensitivity (range)	Specificity (range)	PPV <sup>a</sup> (95% CI)	NPV <sup>b</sup> (95% CI)	Agreement <i>k</i> (95% CI)
	Number of participants positive for dehydration	Number of participants negative for dehydration	Number of participants Positive for dehydration	Number of participants Negative for dehydration					
Admission	11	30	8	33	0.50 (0.16–0.84)	0.77 (0.59–0.90)	0.36 (0.11–0.69)	0.86 (0.67–0.96)	0.24 (-0.09–0.57)  Fair agreement
Study exit	6	26	5	26	0.00 (0.00–0.52)	0.78 (0.56–0.92)	0.00 (0.00–0.52)	0.78 (0.56–0.92)	-0.22 (-0.35–0.09)  Poor agreement

<sup>a</sup>PPV = Positive Predictive Value.

<sup>b</sup>NPV = Negative Predictive Value.

## **SECTION 5. Question 3. Barriers and Enablers**

This section outlines the results of the observational assessments and chart audit. Investigations of this information aimed to identify potential barriers and enablers to adequate hydration for older people with cognitive impairment whilst in an acute care environment.

### **Observational Assessments**

Participants were observed over one breakfast ( $n=42$ ), one lunch ( $n=41$ ) and one dinner ( $n=43$ ) during their hospital stay with the specific meal-time observed being dependent upon the availability of research staff.

### **Fluid intake dependency**

At each observation meal patients were assessed for fluid intake dependency (the ability to drink fluids independently) using an item from the Minimum Data Set for Acute Care (MDS-AC) – a valid and reliable tool for the comprehensive assessment of older hospitalized patients (Carpenter et al., 2001). The MDS-AC item assesses the functional ability to eat and drink independently, but for this study only drinking ability was assessed using this item (the ability to eat was not assessed). The item uses a scale ranging from ‘Independent’ to ‘Total dependence’:

0. Independent (No help of staff/oversight OR staff help/oversight provided)
1. Supervision (Oversight, encouragement, or cueing provided only 1-2 times)
2. Limited assistance (Physical help in guided maneuvering to drink 1-2 times)
3. Extensive assistance (Full staff assistance provided 3 or more times for patient to drink)
4. Total dependence (Full staff assistance provided to patient for drinking)

In addition, the following were assessed: whether the patient had been provided with an appropriate drinking vessel (yes/no), the approximate volume of fluid consumed in milliliters (ml) by the patient at each meal, whether the patient had

been offered an alternative fluid if the volume consumed was less than 250 ml (yes/ no), whether the patient had received any encouragement to drink during the meal (yes/no; N/A if all fluids were consumed), and whether the patient was asked whether he/she had finished drinking all offered fluids before the tray was removed (yes/no/ N/A). The specified volume (250 ml) was based on a recommended fluid intake goal of 1,500 ml per day for older adults (J. Menten, 2006a), divided by six (meal-times and mid-meal breaks). Fluids were provided in standard containers and the volume consumed was evaluated visually and recorded using a five-point scale (0, 25, 50, 75, and 100%), which was subsequently converted back to ml consumed. Any difficulties that patients were observed to experience in relation to fluid intake were also documented.

The patient charts and nursing care plans were reviewed within 48 hours of the patient's admission to identify whether: the patient's weight had been documented at the time of admission (yes/no), whether the patient's fluid intake had been documented within the past 24 hours (ml), whether fluid output had been documented at any time (yes/no), whether the patient's fluid output for the past 24 hours had been documented (ml), and whether the patient should be encouraged to increase his/her fluid intake (yes/no).

Finally, a room audit was performed during one meal-time for each study participant to determine whether: drinking water was available in the room (yes/no) and whether the patient could easily reach the water (yes/no). The room audit was performed at the same time as the chart and care plan audits.

### **Observational assessment results**

As displayed in Figure 16 there were a large percentage of participants who were either independent for fluid intake at breakfast (38%;  $n=16/42$ ), lunch (49%;  $n=20/41$ ) and dinner (49%;  $n=21/43$ ) or required some supervision at breakfast (43%), lunch (34%) and dinner (21%). Only 5% ( $n= 2$ ) of the sample required full staff assistance at dinner. There were no participants requiring full assistance for fluid intake at breakfast or lunch time assessments. There were

no statistically significant differences for fluid intake dependencies at any meal-time for patients with CI versus those who were cognitively intact: Breakfast:  $\chi^2 = 3.5$ ,  $df=3$ ,  $p=0.32$ ; lunch:  $\chi^2 = 7.7$ ,  $df=3$ ,  $p=0.05$ ; dinner:  $\chi^2 = 8.7$ ;  $df=4$ ,  $p=0.07$ .

Additionally, there were no statistically significant differences in fluid dependencies when comparing participants who, at **baseline**, were assessed as dehydrated (defined either clinically or according to serum-calculated osmolality readings), compared to those who were not; breakfast:  $\chi^2(3, n=42) = 1.57$   $p = 0.67$ ; lunch:  $\chi^2(3, n=41) = 0.86$ ;  $p = 0.83$ ; dinner  $\chi^2(4, n=40) = 1.67$ ,  $p=0.80$ . Similarly, there were no statistically significant differences in fluid dependencies when comparing participants who, at **exit** from the study, were assessed as clinically dehydrated compared to those who were not; breakfast:  $\chi^2(3, n=30) = 5.3$ ,  $p=0.15$ ; lunch:  $\chi^2(3, n=30) = 5.2$ ,  $p=0.16$ ; dinner:  $\chi^2(4, n=31) = 2.2$ ,  $p=0.70$ .

Audits of care plans found that 27% of participants at breakfast, 15% at lunch and 23% at dinner did not have fluid intake dependencies documented in the patients care plan. This finding showed no difference between the CI and the non-CI group ( $p = 0.21$ , Fisher’s exact test).

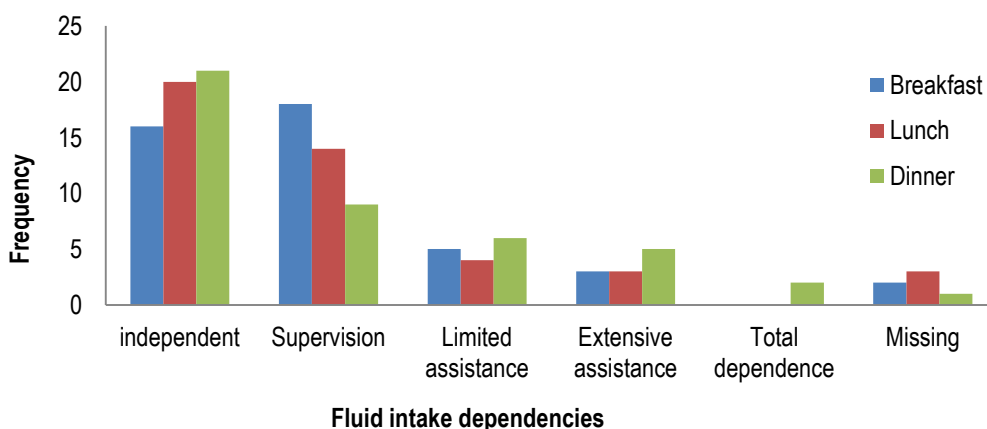


Figure 16. Observed fluid intake dependency for all participants (n = 39)

### Meal time assessments

A total of 42 (95%) participants were assessed at breakfast, 41 (93%) at lunch and 43 (98%) at dinner. The majority of participants (93%) were provided with an appropriate drinking vessel at all meals observed by the research team,

although a patient was provided with a cup with a broken handle on one occasion. The average amount of fluid consumed at each meal observation was 248mls (SD = 85) at breakfast, 190mls (SD = 123) at lunch and 202mls (SD at 141) at dinner time. At no meal-time did all patients drink the recommended minimum of 250 ml, although around one-quarter of patients (Breakfast: 17%,  $n=7$ ; Lunch: 27%,  $n=11$ ; Dinner: 23%,  $n=10$ ) were encouraged to increase their fluid intake by nursing staff on each occasion. In addition, 36% ( $n=15$ ) at breakfast, 42% ( $n=17$ ) at lunch and 51% ( $n=22$ ) were not asked if they had finished drinking all the fluids offered before the meal tray was taken away. These results were no different when comparing the CI group with the non-CI group.

A random room observation was performed during a meal time assessment for each study participant. Results revealed that 8% ( $n=3$ ) did not have evidence of drinking water in their room and 30% ( $n=12$ ) of those who had drinking water in their room were not able to easily access it at the time of the observation. Of the 12, three (25%) were assessed as dehydrated at baseline and four (33%) were assessed as dehydrated at study exit. There were no differences for any of these observations between the CI and the non-CI group.

At the time of the room observation (during a meal time assessment), the position of the patient was assessed as:

1. Lying in bed
2. Sitting in bed
3. Sitting in a chair
4. Other

Results are displayed in Figure 17.



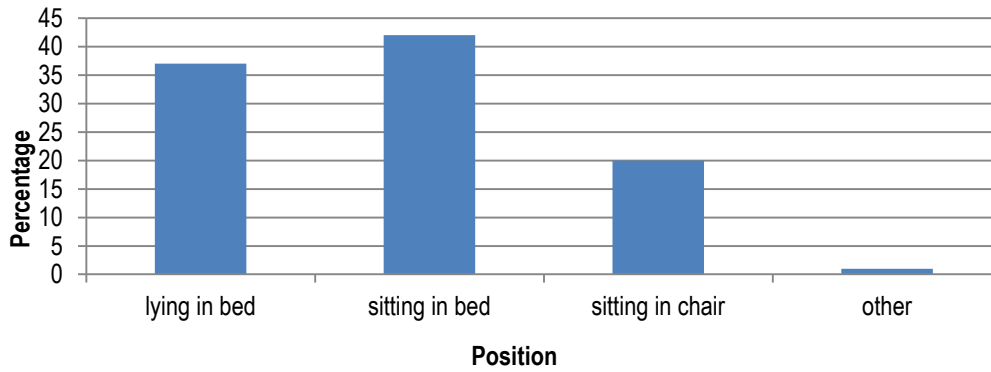


Figure 17. Position of patient during meal time assessment

Some observations were undertaken during snack periods to assess if fluids other than tea or coffee were offered. As claimed by the participants, no different fluids were offered on 61% ( $n=23$ ) of the occasions. One participant commented that, “*you only get what you are offered.*”

### Chart Audit

Chart audits of 41 participants (93%) revealed that **fluid intake** monitoring was documented in fewer than one-third of cases (27%;  $n=12/41$ ), which did not significantly differ according to the patient’s CI status (CI: 27% versus no CI: 33%) ( $p=0.73$ , Fisher’s exact test). Similarly, **fluid output** monitoring was documented in only a minority of cases (15%;  $n=6/40$ ), and again the level of documentation did not significantly differ according to the patient’s CI status (CI: 8% versus no CI: 27%) ( $p=0.18$ , Fisher’s exact test).

Likewise, the documentation of **fluid intake** monitoring in patient’s charts did not differ significantly according to patient’s dehydration status, either at admission or at study exit: **fluid intake** monitoring was documented in 27% of charts of patients assessed as dehydrated (either clinically or according to serum osmolality readings) at admission ( $n=3$ ); and in 30% of patient charts of those assessed as euhydrated at admission ( $n=9$ ,  $\chi^2=0.03$ ,  $df=1$ ,  $p=0.86$ ); **fluid intake** monitoring was documented in 33% of the charts of patients assessed as dehydrated (either assessed clinically or according to serum osmolality

readings) at study exit ( $n=3$ ), versus 28% of patients assessed as euhydrated at study exit ( $n=9$ ;  $\chi^2 = 0.09$ ,  $df=1$ ,  $p=0.76$ ).

This result was similar when comparing no **fluid output** monitoring. There were no differences in the proportion of patients who had **fluid output** monitoring documented in their charts according to dehydration status at baseline (Dehydrated: 10% versus Euhydrated: 17%;  $\chi^2 = 0.26$ ,  $df=1$ ,  $p=0.61$ ) or at exit (Dehydrated: 19% versus Euhydrated: 0%;  $\chi^2 = 1.76$ ,  $df=1$ ,  $p=0.18$ ).

Chart audits also revealed that patient's weight following admission was documented in approximately three-quarters of cases (77%;  $n=30$ ), which differed according to patient's dehydration status at admission. While 84% of patients ( $n=26$ ) who were euhydrated at admission had their weight recorded ( $\chi^2 = 4.11$ ,  $df=1$ ;  $p=0.04$ ), only 50% of patients ( $n=4$ ) who were dehydrated at admission had their weight recorded. Finally, documentation that patients should be encouraged to increase their oral fluid intake occurred in a minority of cases (11%;  $n=5/38$ ), which did not differ according to the patient's dehydration status at admission ( $\chi^2=1.06$ ;  $df=1$ ;  $p=0.3$ ).

## General Observational Findings

Research observers also documented several system related issues. The most frequently observed issue was patients having difficulty opening milk, juice and other containers, while other issues included the non-delivery of meal-trays (one occasion), a patient being unable to re-position himself into a sitting position to eat (one occasion), a patient missing a meal as she was taken to the shower (one occasion) and patients given fluids they did not drink or did not like (three occasions). Observed issues included:

:

### A. Water bottles and milk container issues.

- Two patients, who were assessed as requiring limited assistance for fluid intake was unable to get the lid off the water bottle.

- Another lady with severe arthritis was unable to open the milk and water containers. She attempted to open the yoghurt and fruit container by stabbing it with a knife until the researcher intervened and assisted her. The same lady was given coffee with her dinner despite not liking coffee. No other fluids were offered by staff.
- Three patients had difficulty opening the milk but were assisted by a nurse.
- One patient was unable to open the milk and started to eat her cereal dry.
- Another patient had difficulty opening the milk for her cereal and was unable to get the lid of her water and was assisted by a cleaner as she saw that the lady was struggling. The cleaner also made another cup of tea for the lady.
- Two patients who had a water bottle available didn't have a glass to pour it into, and as stated by one lady, "I don't drink out of bottles". The other lady implied a same belief.

B. Patients requiring assistance

- One patient required his food at dinner time to be cut up by the researcher as he had no teeth insitu.
- One patient with intravenous therapy insitu was not provided with any staff assistance to cut up food despite requiring it. However, at a later meal time assessment the patient was provided with assistance to open packages and pour milk.
- At one breakfast observation a patient was left in a lying position and was unable to position himself to eat. The tray was consequently removed by the kitchen staff without the patient eating any of his meal.

C. Other equipment issues

- One patient was given lactose free milk and a drinking popper however, neither had a straw.
- One patient was given a mug with a broken handle and consequently held the mug by the outside of the mug.

D. Other issues

- One patient informed research staff that she didn't drink tea or coffee and wasn't offered any alternative. This information was not documented in her care plan.
- One patient did not receive a dinner tray so her daughter bought her sandwiches from the café. (researchers arrived after the event)
- On one occasion a participant was not able to finish their breakfast fluids because she was taken to the shower.
- One patient was left to rummage through her drawers trying to find another drink during a lunch time observation
- One patient only had a mouthful of her tea and as she stated, "*it was cold and I prefer hot tea.*"

## **SECTION 6. Discussion**

The aim of this study was to determine the extent of the problem of dehydration in people with and without cognitive impairment during an acute care admission and explore barriers and enablers to adequate hydration. Findings suggested that there were no statistically significant differences in either biochemical results or clinical assessments in relation to the hydration status of the people in the CI group compared to those in the non-CI group. However, people in the CI group were assessed as having more co-morbidities, an increased risk of dehydration and an increased length of stay than those in the non-CI group. Significant system related issues were identified in this project, and if addressed, may improve the quality of care and safety of older people admitted to an acute care environment.

This sample represented a population of frail (61%), older (Av. age = 81yrs.) medically ill people admitted to an acute care environment. All participants from the delirium superimposed on dementia group were classified as frail and 75% of those who had delirium were categorised as frail. Next highest in frailty prevalence were participants in the dementia group (60%) and finally the lowest percentage (53%) of “frail” participants were seen in the non-CI group. These findings support previous findings where delirium was associated with higher levels of frailty (E. M. Eeles, White, O'Mahony, Bayer, & Hubbard, 2012).

An understanding of frailty is important as it may be used as a measure of survival prediction. For example, a previous study found that survival was lower with increasing frailty (K. Rockwood et al., 2007). Frailty refers to an appearance of accumulated deficits as a person ages (Kenneth Rockwood & Mitnitski, 2011). Although a different syndrome, delirium is also associated with increased risk of death (E. Eeles et al., 2010; Quinlan et al., 2011). Consequently, a combination of increasing frailty and delirium represents a significant health issue that requires further research as both are associated with increased rates of mortality.

As noted previously the diagnosis of dehydration can not be made by one test. For this study we utilised a number of hydration markers including short term weight loss, clinical assessments and biochemical results. In addition to diagnostic complexities, dehydration itself is a complex phenomenon with many potential causes. However, if dehydration is suspected the underlying cause should be investigated and treatment goals instituted (Forsyth et al., 2008).

Currently, most research into dehydration has been undertaken in long-term care facilities. For example, a recent systematic review found that dehydration to be a significant problem in institutionalized older people with reported rates as high as 31% (Begum & Johnson, 2010). Hospitals are an important part of any health care system and as the population ages it can be expected that more older people with complex issues will seek the services available in an acute care environment. Older people typically have more complex, high care needs which can place them at significant risk while in hospitals. Similar to the population in residential aged care facilities, the risk of dehydration is greater in this population in acute care (Begum & Johnson, 2010).

In fact, a 2008 US study of geriatric psychiatry patients found that approximately 25% of their sample had characteristics indicative of dehydration on admission (Forsyth et al., 2008). Reports from the US claim that over a ten year period (1990 – 2000) the rate of dehydration-related hospitalizations increased by approximately 40% (European Food Safety Authority Panel on Dietetic Products, 2010). Within Australia the prevalence of dehydration in people aged over 60 years admitted to a geriatric and rehabilitation unit was found to be 16.3% (Vivanti et al., 2008). In contrast, we found 27% of the sample to be clinically assessed as suspected dehydration on admission to the hospital which is higher than the previous Australian findings.

At exit from the study 19% of the participants were still considered to be dehydrated via clinical assessments and 16% were considered to have “impending dehydration” or “potential dehydration” as defined by serum osmolality at exit from the study. Given this assessment was undertaken at a maximum of day four after admission ongoing assessments may have yielded

different results. However, a recent UK study, using serum osmolality markers to define dehydration, reported that 44% of the sample of patients 65 years of age or older, were “*dehydrated when reviewed 48 hours after admission*” (El-Sharkawy et al., 2014). Of interest is the fact that our rate represented a higher percentage of participants in the non-CI group (29%) compared to those in the CI group (22%). However, there was a large amount of missing data at this time point and the high percentages represented only five participants in the non-CI group and six participants in the CI group. Further research is required to determine if these high percentages are replicated in larger samples.

Despite the missing data, we found that there were no new episodes of clinically assessed dehydration at exit from the study in the non-CI group. However, two participants in the CI who were clinically assessed as dehydrated at exit from the study but not baseline. Although not statistically significant this finding may be considered clinical significant as this figure represents, 13% of the CI group who had a new clinical assessment of dehydration at exit from the study and overall 67% of the CI participants were clinically assessed as dehydrated at exit from the study. These results imply that there were hospital related factors that may have contributed to this change in hydration status for people with CI.

Although not statistically significant, this study identified that 30% of the “frail” participants were assessed as dehydrated at baseline and 27% at exit from the study compared to 29% and 9% respectively of the “fit” participants (based on clinical assessment or serum osmolality readings). At exit from the study there continued to be a greater percentage of “frail” participants who were assessed as dehydrated compared to those who were classified as “frail” (27% Vs 9%).

When assessing serum osmolalities, in our sample, approximately 19% of the participants were considered to have either impending dehydration or dehydration at baseline. This result included 18% of participants from the non-CI group and 19% from the CI group. Additionally, serum sodium levels were found to be significantly different in the CI group from baseline to exit from the study. However, this finding was not clinically significant as results were not above the higher reference range limit of 145mmol/L. Similarly, the statistical

significant differences in the urea/creatinine ratios were not clinically significant as they were within the reference range of 40 -100.

There were no differences between participants from the CI group compared to those in the non-CI group at baseline ( $p=0.66$ ) or exit from the study ( $p=0.83$ ) with similar percentages for both groups being identified as dehydrated at baseline and exit from the study. However, there was a statistically significant association identified between the combined (clinical assessment and serum calculated osmolality) hydration markers and the two frailty categories (“fit” and “frail”) for participants in the non-CI group at baseline. We found that none of the “fit” cognitively intact participants were dehydrated at baseline according to clinical assessment in contrast to 56% of the “frail” non-cognitively impaired group. This result raises the question about frailty and dehydration. Could frailty, rather than cognitive status, be a predictor of dehydration in older people admitted to acute care facilities?

However, this study identified that dehydration risks were significantly higher in the CI group compared to those in the non-CI group. This difference was found even after the CI element was removed from the risk classification. The knowledge of dehydration risks and frailty at baseline may assist health care workers to target specific interventions to those who are at the highest risks including people living with CI.

This study found no statistically significant differences for clinically assessed, short term weight loss or serum osmolality dehydration markers between the CI and non-CI groups however, the small sample size and the short length of data collection (maximum 4 day post-admission follow-up) may have had an impact on our hydration status findings. Despite this finding, it can still be argued that the risk of dehydration for people living with CI is exacerbated for a variety of reasons including an associated increase in length of stay for people with CI to those without CI (Draper, Karmel, Gibson, Peut, & Anderson, 2011; Mukadam & Sampson, 2011), and their increased reliance on others to obtain oral fluids (Amella, 2004).



### **Predictors of Dehydration**

While the prevalence of CI in this relatively small sample was quite high (61.4%), we did not find any relationship between cognitive status and dehydration – a finding that differs from several previous studies that have reported dementia and CI to be risk factors for dehydration in older hospitalized patients (Chen, Dai, Yen, Huang, & Wang, 2010; Zuliani et al., 2012). Those studies were, however, based on much larger sample sizes (n=1,905, 51,838 and 455 respectively) and it is likely the present study's small sample size accounted, at least in part, for the failure to find any relationship between CI and dehydration.

An unsurprising finding in this study was that dehydration at admission significantly predicted dehydration at study exit, as defined by combined measures, and most likely reflects the unchanged status of half of the patients. This finding further underscores the importance of assessing and identifying any issues that frail older patients may experience regarding fluid intake and regularly monitoring their fluid intake while in hospital.

### **Diagnostic accuracy of clinical assessment compared to serum-calculated osmolality (CO)**

Results showed fair agreement between the clinical assessment of dehydration and that diagnosed by CO at admission and very poor agreement at exit. On both occasions, sensitivity was very poor (admission: 0.50), particularly at exit (0.00), in which case there was no agreement between the clinical assessment and CO results. This lack of agreement is likely to be partly attributable to the small sample size and missing data at exit. Otherwise, specificity was moderate at both admission (0.77) and at study exit (0.78), indicating that the clinical assessment was reasonably accurate in identifying euhydration.

While few studies have reported on the accuracy of clinical assessments in predicting dehydration, our findings are consistent with findings previously reported (Fortes et al., 2015). Fortes and colleagues found that 21% of their

sample of older patients (aged  $\geq 60$  years) admitted to hospital were dehydrated on the basis of CO; a rate similar to our result. They also reported poor sensitivity (0–44%) of each of the physical signs (tachycardia, low systolic BP, dry mucous membrane, dry axilla, poor skin turgor, sunken eyes and long capillary refill time) used by their hospital clinicians to predict CO-defined dehydration. Like us, they also reported that each measure had reasonable-to-good specificity (60–99%) in identifying euhydration.

In this study, clinical dehydration was established following assessment of multiple physical features. More extensive research is required to determine whether individual elements of clinical dehydration assessments are more predictive of dehydration than others. However, until a specific measure is developed or identified, our results serve as a useful reminder that clinicians should not rely solely upon clinical dehydration assessments for older patients, but that they should confirm their suspicions through pathology results. By comparison, it seems that experienced clinicians may have a degree of confidence in their assessments when concluding that a patient is euhydrated. This finding is encouraging for clinicians working in rural and remote areas, or in other settings (e.g. primary care) where ready access to pathology services may be limited. It should be borne in mind, however, that the clinicians who performed clinical assessments in this study were experienced geriatricians, and their findings might not be extrapolated to less experienced clinicians.

### **Observational findings**

In this sample, between 47% and 70% of the participants did not consume the anticipated amount of 250mls per meal. The European Food Safety Authority Panel on Dietetic Products, Nutrition and Allergies (EFSA) recommends that adults consume 5 – 7 cups (250mls) of fluid each day (European Food Safety Authority Panel on Dietetic Products, 2010). This finding was similar for both groups. Although not statistically significant the finding is clinically significant as people with CI are less likely to ask for, or seek out alternate fluids. Additionally, older people, even those without cognitive impairment have impaired thirst responses and may also be less likely to seek fluids.

We found that many participants were not encouraged to drink more or were not asked if they had finished drinking the fluids offered, when the meal trays were taken away. In addition, 30% of the participants did not have drinking water within reach at the time that the room audit was undertaken, while 87% did not have any reference to encouraging oral fluids, documented in their care plans despite having a significant number of risks for dehydration. Reminding older people to drink fluids has been shown to effectively increase fluid intake in nursing home residents, (Simmons et al., 2001) and is an easy intervention to implement, requiring minimal staff time.

Furthermore, while more than half of the patients in this study required some level of assistance with fluid intake at meal-times, fluid intake dependencies were documented in only a minority of patient care plans. The lack of fluid monitoring by way of fluid balance charts in this study was also low and is consistent with previous findings that fluid balance charts are poorly completed (Reid et al., 2004). While under-documentation was identified, and does not necessarily indicate that a particular activity was performed or not (Cox et al., 2003), the completion of fluid balance charts is important for the early identification of dehydration and the ongoing monitoring of patient's hydration status (J. C. Menten & Kang, 2011). Furthermore, accurate record keeping is integral to safe and competent nursing practice (Nursing and Midwifery Board of Australia, 2008).

Inability to access fluids because of packaging was found to be an important issue in the meal time observations of this group of older patients. Many couldn't open the milk or water containers, sometimes due to physical incapacity, and this result was found in both the CI and the non-CI group. Additionally, some patients were not adequately provided with the assistance they required to effectively manage fluids. Patients reported that they weren't offered alternative fluids and this issue may be easily addressed by understanding patient's personal preferences for oral fluids on admission to hospital. The chart audits found no evidence of personal fluid preferences in any of the reviews. On a positive note, drinking vessels that were provided to

patients appeared to be appropriate and most patients had drinking water available.

### **Protected Mealtimes**

The hospital has a policy of protected mealtimes with all non-essential clinical assessments actively discouraged during meal-times and the provision of meal-time assistance to patients advocated. Despite this, our results showed that meal-time assistance was not always provided when needed, and although the aim of protected meal-times is to allow patients to eat in an undisturbed environment, unintentional consequences may include inadequate supervision or assistance. In this study, fluid intake strategies including encouragement to increase fluid intake, were most frequently implemented at breakfast. Whether this reflects nurse: patient ratios at that time or other factors requires additional research, although it is hypothesized that nursing numbers may be reduced during lunch and dinner times due to delegated staff meal breaks.

Our findings indicate the need for practice and system-related changes to promote adequate hydration and prevent dehydration in older hospitalized patients. This includes providing education for hospital staff regarding the importance of hydration in older patients, how to correctly monitor and record this information (i.e. how to correctly complete a fluid balance chart), and effective strategies to promote and maintain adequate hydration in this population. Increasing nurses' awareness of the difficulties many older patients face at meal-times in accessing fluids (and possibly food, although food accessibility was not a focus of this study), is required in the first instance. In particular, older patients with arthritic hands or other disabilities are likely to encounter difficulties when opening food or fluid containers, and nurses need to be more aware of these issues. Alternately, easy-to-open containers, or the provision of fluids in appropriately designed vessels via regular fluid rounds, could be considered. In addition, clinical practice and individual care planning should more accurately reflect the needs of older people especially those with CI and other physical impairments. This includes the identification of fluid intake dependencies, patient's fluid preferences and fluid intake goals for patients and recording this information in the nursing care plan where it can be enacted

(Bunn, Jimoh, Wilsher, & Hooper, 2015; J. C. Menten & Kang, 2011; J. C. Menten & J. Wang, 2011). A recent systematic review of interventions in long-term care reported that ensuring greater choice and availability of beverages, increased staff awareness, and increased staff assistance with drinking and toileting were effective in increasing fluid intake or reducing dehydration (Bunn et al., 2015). It is likely that those interventions may also have a positive impact on older hospitalized patients and the establishment of sound systems will not only improve the delivery of quality care but will also support staff through education and training.

### **Study Impact**

The implementation of this study and the presence of research staff on the wards during data collection have potentially raised awareness of hydration as an important issue for older hospitalized patients at the study hospital. This, together with the dissemination of the study findings at in-service presentations and informal discussions amongst staff have been the impetus for two small but important changes since the study's completion. The first was aimed at addressing patient's fluid preferences through the introduction of a chocolate flavored milk drink (served hot or cold) as an alternative to tea and coffee at mid-meal rounds, and the second has been the replacement of water bottles with jugs and glasses. These small changes have not been difficult nor expensive to implement and may assist to improve the hydration status of older hospital patients and we intend to evaluate the impacts of these interventions.

### **Study Strengths and Limitations**

Strengths of this study include its prospective design and robust diagnostic approach for assessing dehydration. The comprehensive assessment of patients by experienced clinicians and the collection of multiple measures of dehydration within 24 hours of their admission to hospital and again at study exit indicates data regarding patient's dehydration status are likely to be accurate. The use of multiple data collection methods (direct observation and audit) also strengthens the findings regarding the identified barriers and enablers to oral hydration in older hospitalized patients. In addition, the study

reflects everyday clinical practice in a natural setting without research manipulation, and it is likely that the issues we identified also occur in many other hospitals. Hence, senior nursing staff may use our findings to assess the extent to which these or other issues occur in their hospital and perhaps consider implementing the strategies previously outlined to address them.

This study had several limitations. The study was primarily limited (due to financial constraints), by its small sample size and the short in-hospital observation time (maximum of four days). In addition, recruitment was restricted to the early part of the week, meaning the sample may not be representative of all older patients admitted to an acute hospital. Further, some data were missing due to patients being discharged without being followed-up by research staff and meal-time assessments were only undertaken over one breakfast, lunch and dinner and may not have been true representations of the whole hospital admission. Similarly, the chart audits were performed only once for each patient and daily chart audits may have depicted different results. However, the random approach to meal time and chart audit assessments should have negated this issue.

Finally, hospital staff were informed of the patient's dehydration status following the clinical assessment and while this had the potential to influence patient treatment while in hospital, the numbers of patients dehydrated at study exit suggests this was not the case. Finally, the presence of research staff who performed patient observations may have potentially influenced nurses' behaviors during the observations. The extent to which nurses' behavior may have been influenced by the presence of the data collectors cannot be known, although the potential impact was mitigated by ward nurses being unaware of the precise nature of the data being collected. Another limitation includes using the study investigators as data collectors (JMc, MM), which is a potential threat to the validity of the data collected, due to the possibility of bias (known or unknown). Balanced against the risk, however, was the advantage of having very experienced gerontological nurses perform the data collection. Finally, while the use of a non-validated tool also limits the study's validity, the tool was evidence-based and as many of the data items required an objective 'yes' or

'no' answer, the risk of bias by relying on subjective interpretation was mitigated. Nevertheless, the reliability, validity and comprehensiveness of the tool used in this study is unknown, although the lack of such a tool identified in this study may provide the impetus for the development of an appropriate instrument for assessing hydration in older hospitalized patients. Finally, not all potential barriers and enablers may have been identified in this study and a larger scale study may identify additional barriers and enablers which may vary across different hospitals and wards.

In spite of these limitations, a number of practice and system-related barriers and potential enablers to the maintenance of adequate hydration in older hospital patients were identified. Addressing this issues is likely to not only improve the quality of hospital care for this patient group but may also assist to prevent dehydration. Preventing dehydration may be as simple and cost-effective as providing fluids in receptacles that older people can easily open, documenting fluid preferences and fluid intake strategies in care plans and providing patients with preferred drinks. Strategies to improving hydration practices in acute hospitals should be explored using appropriate research methodologies and testing strategies in both cognitively impaired and cognitively intact populations. Importantly, sound research into the most effective ways of implementing and embedding such practices within everyday nursing practice is required.

## **Conclusion**

This study found a relatively high prevalence of suspected dehydration in both people with CI and those without CI at admission to hospital and on exit from the study. The CI group had significantly more dehydration risks and consequently need further research to understand the impact of these risks on hospital outcomes. The high rate of dehydration and increased number of dehydration risks is a significant health issue as dehydration is associated with poor outcomes for older people (Wakefield, Mentes, Holman, & Culp, 2008).

This study found higher rates of dehydration in the “frail” cognitively intact participants compared to those in the “fit” cognitively intact group. Consequently, frailty may be a predictor for dehydration however, there possibly are other risk factors for dehydration in cognitively intact older people in hospital that we did not measure. Further exploration of these factors would potentially benefit both CI and non-CI groups.

In addition, several system related issues were identified that, if addressed, may prevent dehydration. Preventing dehydration may be as simple and cost-effective as providing fluids in receptacles that older people can easily open, documenting fluid preferences and fluid intake strategies in care plans and giving someone a preferred drink. Ways of improving hydration practices in acute care should be explored using appropriate research methodologies, testing strategies in both cognitively impaired and non-cognitively impaired populations, and in frail and non-frail populations.

Finally, it is recommended that clinicians do not rely upon the clinical assessment of dehydration, without also using the reference standard – serum-calculated osmolality. To do so may result in failure to identify dehydration in this population with potentially serious consequences.



## PUBLICATIONS

The following articles, based on this study, have been published:.

McCrow J, Morton M, Travers C, Eeles E, Harvey K. (2016). *Salt in the desert: A comparison of clinical versus serum-calculated determination of dehydration*. Healthy Aging Research (20/04/2016). <http://www.har-journal.com/archives/1600>

McCrow J, Morton M, Travers C, Eeles E, Harvey K. (2016). *Associations between dehydration, cognitive impairment and frailty in older hospitalized patients: An exploratory study*. Journal of Gerontological Nursing. 42(5): 19-27. DOI: 10.3928/00989134-20160201-01

McCrow J, Morton M, Travers C, Eeles E, Harvey K. (2016). *Water, water everywhere: Dehydration in the midst of plenty: An observational study of barriers and enablers to adequate hydration in older hospitalized patients*. Clinical Nursing Studies. 4(2). First published online 20/01/2016. <http://dx.doi.org/10.5430/cns.v4n2p1>

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