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Title: A descriptive study of the fluid intake, hydration and health status of rehabilitation inpatients without dysphagia following stroke

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Abstract:

Adequate hydration is important for all people particularly when hospitalized with illness. Individuals with dysphagia following stroke are considered to be at risk of inadequate fluid intake and, therefore, dehydration but there is little information about the fluid intake or hydration of individuals *without* dysphagia post-stroke. This cohort study measured the average beverage intake, calculated the urea/creatinine ratio as a measure of hydration, and documented specific health outcomes of 86 people *without* dysphagia post-stroke who were inpatients in rehabilitation centres. Participants drank on average 1504ml per day (SD 359ml) which typically represented 67% of their estimated daily requirement. Approximately 44% of the participants in the sample were dehydrated based on a Blood Urea Nitrogen/Creatinine ratio >20:1. Sixteen percent of participants were diagnosed with one or more of the health outcomes of dehydration/hypernatremia, urinary tract infection or constipation. A greater level of dependence was associated with poorer beverage intake and higher risk of an adverse health outcome. Those in the older/elderly age range (particularly older women) and those with poor mobility were most at risk of poor hydration. This study highlights that patients in rehabilitation facilities post-stroke, even without dysphagia, may be at risk of sub-optimal fluid intake and hydration.

Key words: Drinking, Deglutition Disorders, Stroke, Water-Electrolyte Imbalance, Rehabilitation

Introduction

Sufficient fluid intake is important for healthy people and critical in the recovery phase of illness or disease [1]. Insufficient fluid intake may lead to dehydration, which in turn can have a significant negative impact on physical and cognitive function, overall recovery and quality of life [2]. Dehydration is particularly concerning for patients in the acute phase following stroke as it may affect the ischaemic penumbra, induce neurological deterioration, and influence the evolution of the stroke itself [3] and is associated with poorer outcomes at hospital discharge with regard to survival rate and dependency [4,5].

Dysphagia (swallowing impairment) is thought to place individuals at higher risk of inadequate fluid intake. The literature has demonstrated that, especially if reliant on oral intake alone, individuals with dysphagia following stroke often present with inadequate fluid intake [6-8] and dehydration [9].Therefore much of the research regarding fluid intake and hydration in the stroke population has involved patients presenting *with* dysphagia. One study comparing the fluid intake of hospitalized patients post-stroke with and without dysphagia found those without dysphagia permitted thin liquids drank significantly more than those with dysphagia prescribed thickened liquids (mean of 1237ml and 947ml, respectively), although only one patient from the total sample of patients met the minimum standard of fluid intake set at 1500ml [10]. Dehydration, based on biochemical analysis, has been demonstrated by 36 - 66% of patients presenting with or without dysphagia in the acute phase following stroke [11,4], although patients with dysphagia had significantly worse hydration at discharge compared to their non-dysphagic counterparts [11]. Evaluating a control group of patients *without* dysphagia following stroke is warranted to determine whether sub-optimal oral fluid intake of the patients with dysphagia [6-8] is solely related to their swallowing impairment or other factors. Whilst fluid intake was not related to any dependency factors in a study of 121 residents in a long-term care facility [12], it is unknown whether stroke-related deficits in mobility, self-care, communication, cognition, toileting and fear of incontinence may play a role in sub-optimal fluid intake of patients in rehabilitation settings. Furthermore, as suggested by Kayser-Jones et al [13], institutional frameworks may affect fluid intake; access to beverages may be limited to prescribed times and only when staff are available to assist those who are dependent; and there may be inadequate systems for monitoring fluid consumption and hydration [14]. As such, any patient presenting with stroke (with or without dysphagia) may be at critical risk of insufficient fluid intake and dehydration.

Aims

The aim of this study was to measure the average daily beverage intake *and* hydration status of a cohort of hospitalized patients presenting *without* dysphagia following stroke to determine whether and to what extent they are at risk of dehydration and adverse health outcomes. This study particularly focussed on patients in rehabilitation settings and those on oral only diets.

Methods

The study was conducted as a descriptive study across three inpatient rehabilitation facilities in an Australian city over 20 months from 2009 to 2011. Ethical approval for the study was granted by the relevant Health Research Ethics Committees. Patients admitted to the rehabilitation units were screened for inclusion and written consent was obtained after a verbal and written (including pictorial) explanation of the research. Family members provided consent if patients were unable to due to aphasia, cognitive impairment or inability to comprehend English, but only after the patient's wishes were confirmed [15,16]. Of the 462 stroke admissions screened, 188 presented with exclusion criteria and 96 declined consent. The main reason for refusal was the requirement for blood tests or competing demands on their time in rehabilitation. Ninety-three patients were recruited and after seven subsequent withdrawals (for similar reasons cited above), 86 complete data sets proceeded to analysis.

Patients were included if they had an admission diagnosis of ischaemic or haemorrhagic stroke (according to ICD-10 coding), were an inpatient in a stroke rehabilitation unit, had a clinical assessment conducted by a qualified and experienced speech-language pathologist who classified them as being non-dysphagic based on clinical assessment of swallowing and were consuming a general diet and normal fluids. Patients were excluded if they had clinical signs of dysphagia, a history of a neurological condition (including dementia) or head and neck cancer/therapy which may have impacted swallowing pre-stroke, were acutely unwell, or required fluid supplementation or restriction.

Clinical assessment of swallowing was conducted by the first author or by an experienced speech-language pathologist from the rehabilitation facility and included an oro-motor assessment, mealtime observation [17], a timed 150ml water test [18,19] and an oral health assessment [20]. To be classified as non-dysphagic and therefore eligible for inclusion, participants needed a 'no abnormality detected' rating on the oro-motor and mealtime assessment according to the AusTOMS criteria [17] for dysphagia and aspiration and pass the water test according to the norms for age and gender.

Stroke characteristics were recorded including the date of onset, nature and location of the stroke, and the presence or absence of stroke co-morbidities such as aphasia, apraxia of speech, ideational or motor apraxia, dysarthria or cognitive impairment. Mobility was categorised as bed-bound, predominantly sitting or exerting to mobilize (either walking or self-propelling in a wheelchair). Dependence for self-care in the specific areas of eating, drinking and oral care was recorded along with an overall independence level as indicated by the Functional Independence Measure (FIM) at admission as determined by the clinical judgement and consensus of the multidisciplinary stroke team. Weight was recorded from the nutritional screen at admission. Some data were not available in some of the participants' records, predominantly admission weight, FIM score or documentation of dependency/mobility. There was no interpolation of these missing data points; only the data collected were used in the analysis hence some results are presented as n<86.

The demographic, clinical and stroke characteristics of participants in this sample are presented in Table 1. The average age of participants was 69 years (SD 11 years) and 64% were male. The mean FIM score at admission (n=64) was 73 (SD 25). The majority of participants (n=52/71, 73%) were exerting themselves to mobilize (i.e. they were able to walk with or without an aid or they were able to self-propel in a wheelchair) and all were able to drink independently from a cup (n=71/71, 100%). All participants were on a general diet and drinking thin fluids.

Three variables were measured prospectively: beverage intake; Blood Urea Nitrogen (BUN) and creatinine (Cr) results; and adverse health outcomes of dehydration or hypernatremia, urinary tract infection, constipation and pneumonia.

All participants were routinely offered approximately 2200ml of beverages per day from the hospital food service system according to standard practice; 1000ml of water in a jug with 100ml graduations by their bedside every 24 hours; and hot or cold beverages in cups of measured sizes (150-250ml) six times throughout the day. Patients could further access drinks from the hospital cafeteria/kiosk or via relatives and friends. Information sheets were provided to participants and family informing them to notify nursing staff if extra drinks were consumed and not to discard residuals in cups or jugs. The purpose was to observe/record intake with no attempt to limit or control the amounts of fluid offered. Daily beverage intake was recorded on fluid balance charts by nursing staff over a period of seven days and the mean daily beverage intake was calculated for each participant. Only *beverages* were included in the calculations for this study (e.g. water, cordial, coffee, tea, soft-drinks, milk, flavoured milk, fruit juices). The total fluid requirement relative to body weight was calculated for each participant, based on a conservative estimate of 30mls of fluid per kilogram of body weight per day [21]. The percentage of actual intake relative to recommended fluid intake was then calculated.

Biochemical analysis was conducted on participants' blood samples taken on entry to the study (day 0) and day 7 of the study. BUN and Cr results were recorded and a BUN/Cr ratio calculated. A BUN/Cr ratio of >20 was used as the cut-off for dehydration in the current study as is commonly reported in the dysphagia literature [9,4,22,23].

The medical diagnoses of dehydration or hypernatremia, urinary tract infection, constipation and pneumonia were recorded from the medical records of participants during their rehabilitation admission. The first three health outcomes were chosen as they are commonly cited as consequences of inadequate fluid intake along with pneumonia which is a commonly cited sequel of dysphagia and therefore a useful point of comparison with the dysphagia literature. Medical diagnoses were made by the treating medical teams as per their standard practices. Whilst there was no formal blinding of data collectors, the measurement and recording of each of these variables was carried out independently by different members of the clinical team.

Statistical Analysis

All data were analysed using the Statistical Package for Social Sciences, version 20.0 [24]. Fluid intake data for all participants (n=86) were normally distributed and thus means and standard deviations were used to describe averages. Data for percentage of required fluids consumed were only available for participants whose weight was recorded (n=55) and only the data of these participants were used in the respective analysis. Similarly BUN/Cr ratio results were available for n=85 on day 0 and n=79 on day 7 so analysis proceeded with these data only. Missing data points were not interpolated or otherwise derived. These subsets of data were also normally distributed and thus means and standard deviations were used to describe averages. Prevalence statistics were used for the categorical measures of the four health outcomes.

To determine whether any of the demographic characteristics or stroke co-morbidities had an impact on fluid intake, percentage of required fluids consumed or hydration measures, the following analyses were conducted: univariate analyses were used to investigate the interaction of variables of age and sex; independent samples t-tests examined binary stroke comorbidities of presence/absence of aphasia, cognitive impairment, dependence for drinking; and one-way ANOVAs examined variables with more than two categories - site of rehabilitation admission, age range, mobility, nature of stroke, range of time post-stroke, location of stroke. The mobility status was available for 71 participants and of these only two were bed-bound. It was decided to combine this group with the predominantly sitting group to form a "not exerting to mobilise" category (n=19) which was then used in a binary comparison with "exerting to mobilise" (n=52) using t-tests.

Pearson's correlations were performed to determine if any of the dependent variables of fluid intake, percentage of required fluid consumed or BUN/Cr ratios were associated with each other. Correlations were performed to determine whether there were associations between any of these outcome measures with the independent continuous variables of age, admission FIM (n=64), or days post-stroke. Effect sizes were calculated for any significant results ($p<0.05$) using Cohen's d coefficient, r values from correlations or regression analysis. Chi square analysis along with logistic regression was performed to determine whether any of the other outcome measures or independent variables had a predictive association with an adverse health outcome.

Results

Fluid Intake

The mean daily beverage intake of the 86 participants was 1504ml (SD 359ml). Of the 55 participants whose weight was recorded only 4 participants (7.3%) fully achieved their required fluid intake relative to their weight. Participants consumed on average 67% of their required fluid intake from beverages. Table 2 illustrates beverage intake of participants and percentage of calculated requirements met according to demographic and clinical characteristics.

None of the demographic factors (age, sex, site of rehabilitation admission) differentially affected fluid intake or the percentage of calculated fluid requirements participants consumed ($p>0.05$). Neither the individuals' stroke characteristics (nature, location, time post-stroke) nor any of the stroke co-morbidities such as mobility or aphasia significantly affected fluid intake ($p>0.05$).

There was a statistically significant but small correlation between FIM score and amount of beverage consumption (r = 0.252, p =0.044) and the percentage of calculated fluid requirements consumed (r=0.314, p=0.020). Admission FIM score was found to be the only statistically significant, albeit weak, predictor of fluid intake (R^2=0.064, F(1, 62)=4.217, beta=0.252, p=0.044), indicating that the more independent, the more likely participants were to meet their individual fluid requirements.

Hydration

The mean BUN/Cr ratio for participants at entry to the study was 19.79 (SD=5.33) and remained stable at day 7 (19.95, SD=5.55, t=-0.427, p=0.671). There was no significant association between beverage consumption and BUN/Cr ratio at day 0 (r=-0.122, p=0.265) or day 7 (r=-0.1, p=0.379). Table 3 illustrates the hydration levels of participants according to various demographic and clinical characteristics. Univariate analysis indicated that age range and sex together significantly affected hydration at day 0 ($F_{(2,84)}$=4.124, p=0.020) with the women in the oldest age group presenting with the poorest hydration levels. Pearson's correlation was statistically significant between participants' age and their BUN/Cr ratio at day 0 ($r=0.234$, $p=0.031$), suggesting that the older the person, the poorer their level of hydration; however, this correlation was again small.

Participants' mobility was the only stroke related co-morbidity that differentially affected BUN/Cr ratios. If participants were unable to exert themselves to mobilize, their BUN/Cr ratio on day 0 was significantly higher, indicating poorer hydration ($t=2.417$, $p=0.018$). Cohen's coefficient indicated a medium effect size ($d=0.58$).

Adverse health outcomes

Forty percent (n=34/85) of the participants presented with an elevated BUN/Cr ratio greater than 20 (suggestive of dehydration) at day 0 and 44% (n=35/79) at day 7. Fourteen participants (16%) had one or more adverse health outcomes: two (2.3%) were medically diagnosed with dehydration or hypernatremia during their admission, seven (8.1%) with urinary tract infection, nine (10.5%) with constipation and none with pneumonia. There was no association between whether the participant experienced one or more adverse health outcomes during their admission and whether or not a participant met their calculated beverage requirements (χ^2 (1)=1.661, $p=0.234$) or had hydration measures that exceeded the normal range (BUN/Cr >20) at day 0 (χ^2 (1)=0.128, $p=0.720$) or day 7 (χ^2 (1)=0.509, $p=0.476$). Admission FIM was the only statistically significant predictor of having an adverse health outcome: the lower the FIM score and therefore the more dependent, the more likely (by 4%) the participant was to have an adverse health event (OR 1.04, 95% CI 1.01-1.08, $p=0.014$).

Discussion

In this study, patients classified as non-dysphagic following stroke consumed on average 1504ml of beverages per day, representing around two-thirds of their required daily intake. This amount is well below the intake of their healthy elderly, community dwelling peers; a cohort of older Australians over 65 years living in the community were reported to consume 2143ml (males) and 1948ml (females) [25]; and a cohort of older community dwelling Americans consumed on average 1961ml) [10]. This comparatively lower intake is of some concern as it could be hypothesised that the patients following stroke would have a similar physiological need for fluids given the level of activity required in rehabilitation.

The hydration measures of this sample of patients without dysphagia (average BUN/Cr ratio of around 20, 44% having a BUN/Cr ratio indicative of dehydration) were worse than a those of a cohort of community dwelling people aged over 70 years from the Australian Longitudinal Study of Ageing [26] who presented with a mean BUN/Cr ratio of 15.85 with only 15% having a BUN/Cr ratio indicative of dehydration. The percentage of participants with poor hydration measures from this sample was similar to that reported for patients with and without dysphagia in *acute* hospitals following stroke (36-66%) [11,4]. Of note, a cohort of acute patients *without* swallowing impairment in a United States hospital had a lower mean BUN/Cr ratio of 16.87 (SD 5.34) seven days following admission, representing better hydration than the present sample, (personal communication, M. Crary from data collected for cited study [11]). This comparison with stroke patients in acute settings raises the question whether fluid intake and hydration levels are adequately monitored in the stroke population as they transition through different care settings, and whether prevention of and interventions for dehydration are implemented in an adequate and timely manner.

Hydration measures were worse for the older participants in this study, especially for women in the older age group (65-75 years), a finding that is consistent with previous research documenting older age and female sex to be independent risk factors for dehydration [4]. Additionally, poor mobility was significantly associated with poorer hydration measures, consistent with literature suggesting the level of functional dependence and the number of confounding medical conditions have a significant impact on fluid intake and hydration [27,21,28,4]

Only the participant's independence level was significantly associated with the amount of beverage consumption; the lower the FIM and more dependent a patient at admission, the lower their average daily beverage intake. Whilst it is acknowledged that the statistical association in this study was relatively weak and should be interpreted with caution, the finding is in line with previous research documenting a relationship between dehydration and stroke severity and impairment in the acute phase post stroke [11,4]. It is intuitive that measures of stroke severity and functional dependence may be a useful adjunct to other relevant clinical measures to identify patients who require greater assistance and encouragement to drink and close monitoring of fluid intake and hydration levels.

Interestingly, neither the amount of fluid intake nor BUN/Cr ratio was predictive of adverse health outcome. Particularly notable was the mismatch between the number of participants clinically diagnosed with dehydration (only 2 participants, 2.3%) and how many (40% to 44%) presented with elevated BUN/Cr. This demonstrates the multifaceted nature of the clinical diagnosis of dehydration [22]. It also further highlights that a single biochemical index does not always correlate with clinical diagnosis of dehydration that is typically based on a combination of the patient's clinical presentation, weight loss reflecting water depletion and multiple other biochemical indices in the context of other medical conditions such as kidney and cardiac disorder and medication use [29,30,2]. Alternatively, because surveillance of hydration by the treating clinical teams was entrusted to normal practice, it may have been inadequate, with subsequent under-diagnosis and under-reporting of dehydration.

It is acknowledged that this study had methodological limitations inherent in conducting research in real-life clinical settings and the findings should be interpreted in this context.

Specifically, the use of fluid balance charts as a measure of fluid intake may have resulted in inaccurate amounts being recorded, despite regular training of nursing staff, clearly measured containers and information sheets to participants and families. Furthermore, the amount of fluid offered to individual participants in this study was not controlled and may have therefore varied between individuals which may have differentially influenced consumption. The classification of participants as not having dysphagia was based on a clinical assessment alone which could have resulted in the erroneous inclusion of some patients with sub-clinical dysphagia. However, the study sought to describe the intake of patients on normal diets post stroke and this aim was met. The clinical diagnosis of dehydration is complex and highly variable in any clinical setting. The use of a single biochemical metric is a limitation of this study and may have contributed to the lack of correlations between fluid intake and hydration measures and medically diagnosed dehydration. Furthermore, a descriptive study is not a research design from which causal relationships can be derived.

Nonetheless the findings indicate that a large proportion of patients presenting with stroke, even those with unimpaired swallowing function, are at risk of poor fluid intake and dehydration compared to the healthy elderly living in the community. Development of guidelines and training programs that address health care staff responsibilities in monitoring and improving patient fluid intake and hydration levels is warranted.

Take away points

- Many patients in post-stroke rehabilitation settings, especially the more dependent, do not drink enough fluids
- Many, especially older females, exhibit signs of dehydration that are unrecognised
- It is important for staff to monitor the fluid intake and hydration of *all* patients following stroke, not only those with dysphagia

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Table 1. Participants' demographic, clinical and stroke characteristics

		N	(%)
Total sample		86	(100)
Sex	Male	55	(64)
	Female	31	(36)
Age range	41-64 years	29	(34)
	65-75 years	26	(30)
	>75 years	31	(36)
Stroke Type	Infarct	71	(83)
	Intracerebral haemorrhage	15	(17)
Stroke Location	Cortical	58	(68)
	Sub-cortical	15	(17)
	Brainstem	7	(8)
	Cerebellar	6	(7)
Stroke Lateralization	Left	42	(49)
	Right	40	(46)
	Bilateral	4	(5)
Time post stroke at entry to study	1-14 days	15	(17)
	15-30 days	31	(36)
	30-90 days	35	(41)

	>90 days	5	(6)
Stroke co-morbidities	Aphasia	29	(34)
	Cognitive impairment	25	(29)
	Not exerting to mobilise (bed-bound or predominantly sitting)	19/71	(27)
	Motor or ideational apraxia	12	(14)
	Dependence for oral care	7/71	(10)
	Dysarthria	21	(24)
	Apraxia of speech	10	(12)
	Dependence for pouring drinks	6/71	(9)
	Dependence for drinking from a cup	0/71	(0)

Table 2. Beverage intake and calculated fluid requirements according to participants' demographic and clinical characteristics

		Daily beverage intake in ml Mean (SD)	p value	% met of calculated fluid requirement	p value
Total sample		1504 (359)		67	
Sex	Male	1534 (370)	0.314	65	0.591
	Female	1452 (336)		68	
Age range	41-64 years	1525 (363)	0.448	63	0.723
	65-75 years	1557 (379)		68	
	>75 years	1441 (339)		68	
Mobility	Not exerting to mobilize	1568 (475)	0.318	62	0.264
	Exerting to mobilize	1467 (330)		68	

Table 3. Hydration measures and adverse health events according to participants' demographic and clinical characteristics

		BUN/Cr ratio day 0 Mean (SD)	p value	BUN/Cr ratio day 7 Mean (SD)	p value
Total sample		19.79 (5.33)		19.95 (5.55)	
Sex	Male	19.31 (5.20)	0.274	19.08 (5.14)	0.078
	Female	20.63 (5.52)		21.35 (6.00)	
Age range	41-64 years	18.37 (5.61)	0.049*	19.39 (6.04)	0.069
	65-75 years	19.16 (3.86)		18.46 (4.69)	
	>75 years	21.61 (5.75)		21.82 (5.49)	
Mobility	Not exerting to mobilize	22.80 (5.97)	0.018*	22.03 (6.60)	0.180
	Exerting to mobilize	19.42 (4.91)		19.85 (5.36)	

* significant at p<0.05

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