Idratazione:
l'approccio funzionale dal sano al patologico

BRAIN AND MALNUTRITION
Chronic Diseases Association ONLUS

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Membro delle società ISEBI, ESPEN, ECSS, ESC

Programma

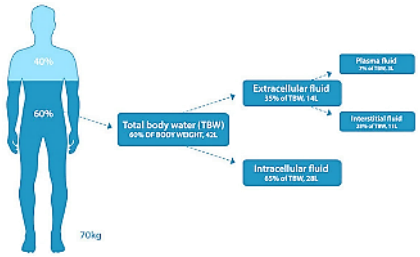
Definizione, fisiologia e valutazione

Idratazione nel sano

Idratazione nel patologico

IDRATAZIONE: definizioni ……

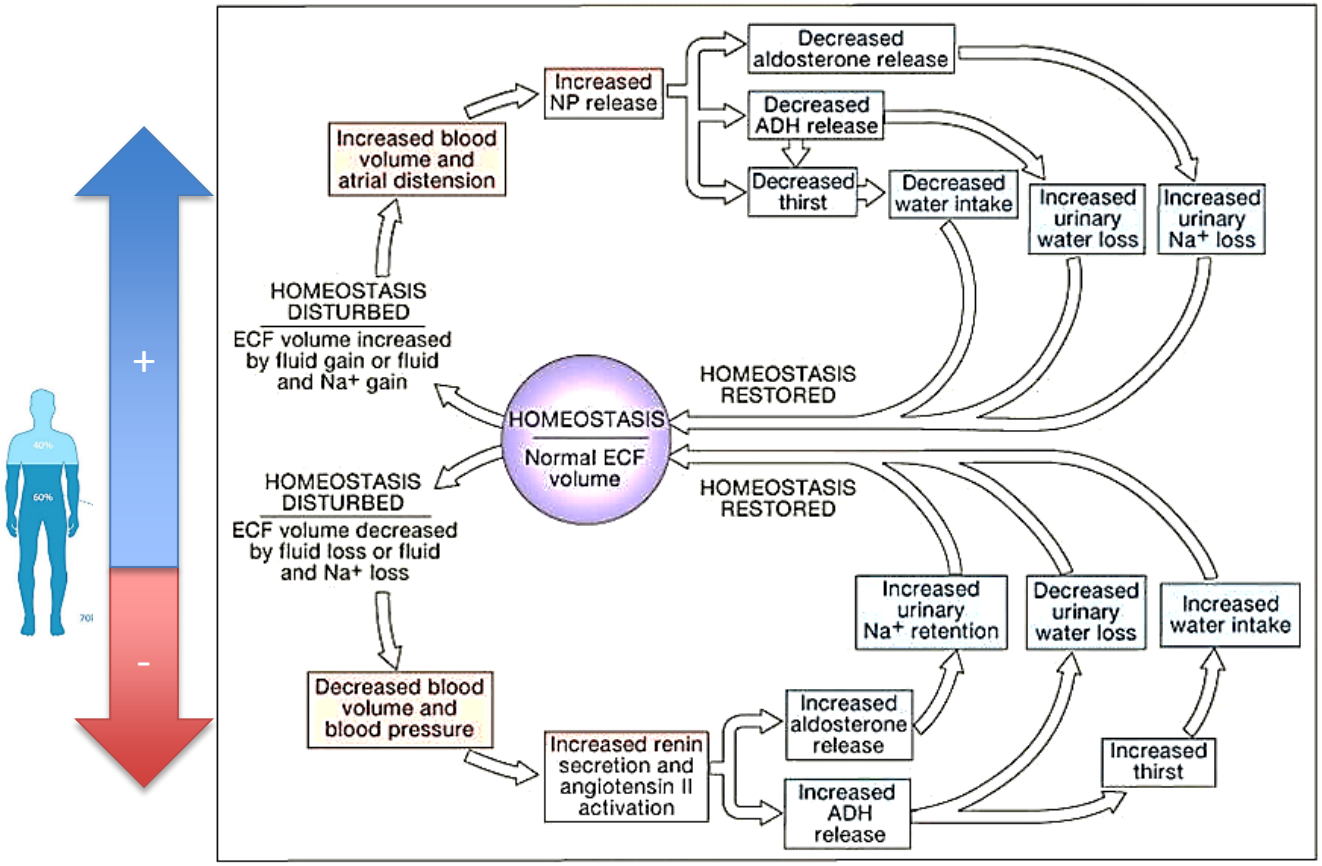
- Definizione fisiologica
- Definizione medica (patologia dipendente)
- Definizione dinamica (equilibrio omeostatico)
- Definizione funzionale nell'atleta (prestazione dipendente)
- Definizione volumetrica (rapporto tra volumi intra ed extra cellulari)
- Definizione vascolare (volemia)
- Definizione chimico analitica (rapporto tra concentrazioni ioniche)



*"The condition of having **adequate fluid** in the body tissues"**

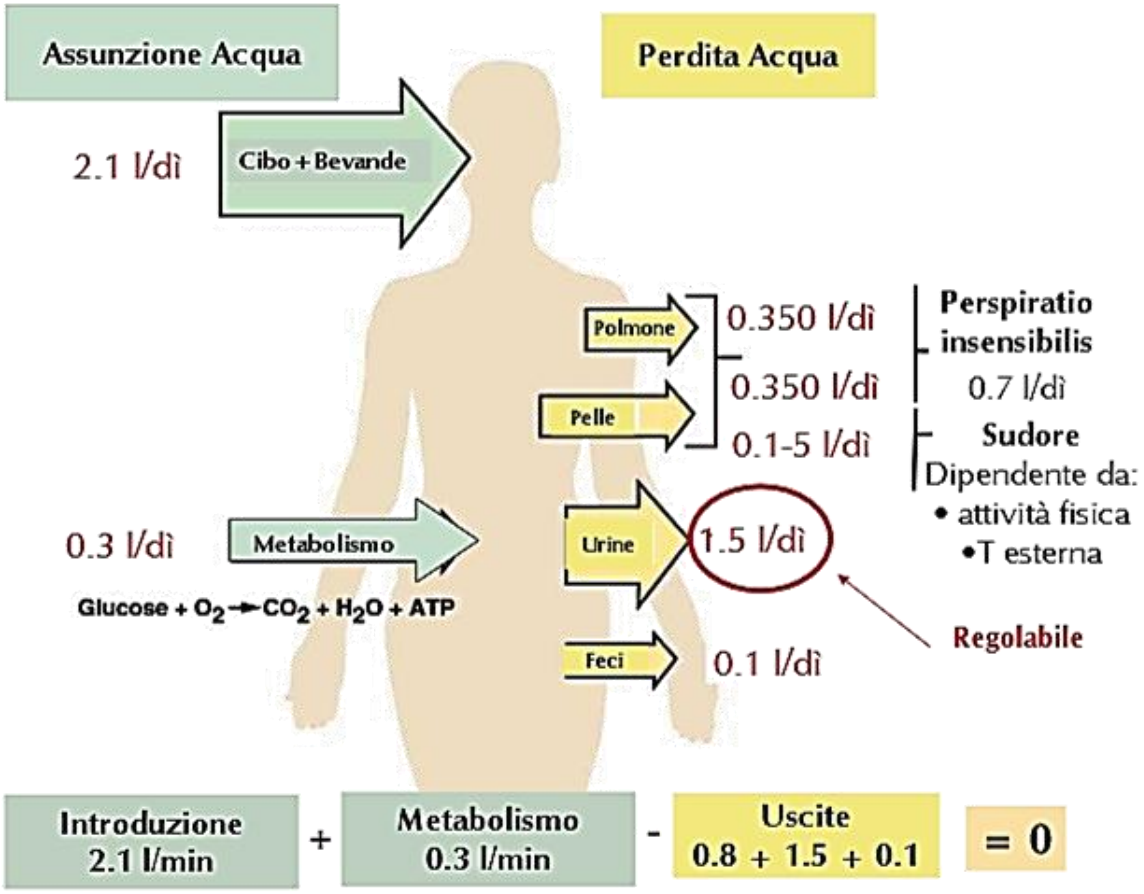
*Guyton And Hall Textbook Of Medical Physiology

«Adequate fluids»= EQUILIBRIO DEI FLUIDI CORPOREI



Guyton And Hall Textbook Of Medical Physiology

Il bilancio idrico nel «sano»



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Gestire la euidratazione nel sano

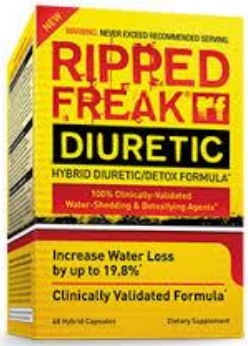
Ripristino del bilancio idrico

Mantenimento del bilancio idrico

Evans, Gethin H., et al. "Optimizing the restoration and maintenance of fluid balance after exercise-induced dehydration." Journal of Applied Physiology 122.4 (2017): 945-951.

Stress “fisiologico” della omeostasi idrica

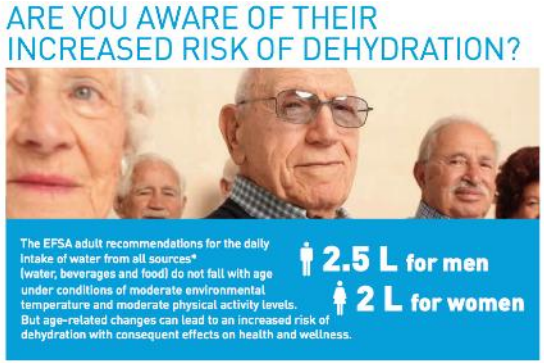
Attività fisica



farmaci

Abitudini alimentari

clima



invecchiamento

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Le alterazioni nel soggetto sano

STATO DI EUIDRATAZIONE
IN=OUT
Mantenimento nel tempo

IPOIDRATAZIONE
- **Acuta per sudorazione**
- **Cronica per deficit intake**

Prevalenza negli sportivi-> 50%-100% (Noakes, 2015)

Prevalenza nella popolazione sana 0,5 -2%; (Stookey, 2005)

Prevalenza nella geriatria 16-30% (Vivanti et al., 2008)

IPERIDRATAZIONE
- **iponatremia esercizio associata (EAH)**
- **dieta**
- **Flogosi sistemica**

Prevalenza negli sportivi - EAH: 0,1%-5% (Carter 2008 -Hew-Butler T, 2017)

Prevalenza in gravidanza – 1%

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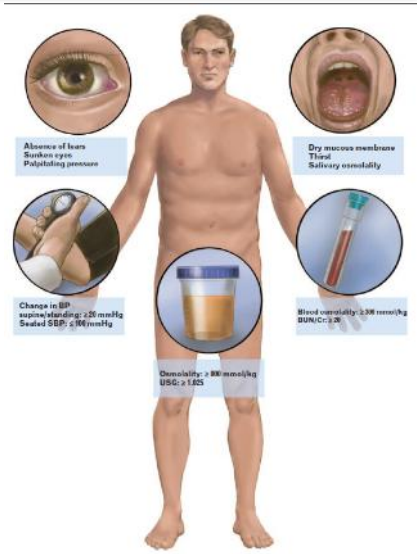
Valutazione dello stato di idratazione

Valutazione della idratazione: una grande sfida

Hydration assessment techniques	Patient self-evaluation	Cost efficiency	Time efficiency	Simplicity of test	Scientific value[c]
Signs and symptoms					
Dry mucous membrane		●●●●●	●●●●●	●●●○○	●○○○○
Skin turgor		●●●●●	●●●●●	●●○○○	●○○○○
Nail bed refill time (s)		●●●●●	●●●●●	●●●○○	●○○○○
Thirst sensation (thirst scale rating)	✓	●●●●●	●●●●●	●●●●●	●●●○○
Respiratory pattern		●●●●●	●●●●●	●●●●○	●○○○○
Dry axilla		●●●●●	●●●●●	●●●●●	●○○○○
Seated SBP (mmHg)		●●●●●	●●●●○	●●●●○	●●●●○
Blood pressure change[a] (mmHg)	✓	●●●●●	●●●●○	●●●●○	●●●●○
Heart rate change (beats/min)	✓	●●●●●	●●●●●	●●●●●	●●○○○
Absence of tears		●●●●●	●●●●●	●●●●●	●○○○○
Sunken eyes		●●●●●	●●●●●	●●●●●	●○○○○
Palpated intraocular pressure		●●●●●	●●●●●	●●●●●	●○○○○
Dark urine color (color chart rating)	✓	●●●●●	●●●●●	●●●●●	●●●○○
Body mass (kg)	✓	●●●●●	●●●●●	●●●●●	●○○○○
Clinical diagnostic laboratory tests					
Blood urea nitrogen/creatinine ratio		●●●○○	●●●○○	●●●○○	●●●●○
Serum sodium concentration (mEq/l or mmol/l)		●●●○○	●●●○○	●●○○○	●●●○○
Blood osmolality, calculated (mOsm/kg or mmol/kg)		●●●○○	●●●○○	●●○○○	●●●●○
Hematocrit/hemoglobin ratio		●●●○○	●●●○○	●●●○○	●●●○○
Mean corpuscular volume (fl)		●●●○○	●●●○○	●●●○○	●●●○○
Urine specific gravity		●●●●●	●●●●○	●●●●○	●●●●○
Research measurements					
Isotope dilution, total body water (l)		●○○○○	●○○○○	●○○○○	●●●○○
Neutron activation analysis, fluid volumes, and ionic content		●○○○○	●○○○○	●○○○○	●●●○○
Bioelectrical impedance analysis, total body water (l)		●●●●○	●●●●○	●●●●○	●●●○○
Body mass (kg)	✓	●●●●●	●●●●●	●●●●●	●○○○○
Blood osmolality, measured[b] (mOsm/kg or mmol/kg)		●●●○○	●●●○○	●●●○○	●●●●○
Urine osmolality (mOsm/kg or mmol/kg)		●●●●○	●●●●○	●●●●○	●●●●○
Salivary osmolality (mOsm/kg or mmol/kg)		●●●●○	●●●●○	●●●●○	●●●●○
Tear osmolality (mOsm/l or mmol/l)		●●●●○	●●●●○	●●●○○	●●●○○
Intraocular pressure (mmHg)		●●●●○	●●●○○	●●●○○	●●○○○



"sappiamo che il turnover dell'acqua totale è complesso e che non esistono misure e marker con validità assoluta per tutte le situazioni, questa review ***<u>valuta 28 tecniche diverse</u>*** *per analizzare la idratazione "*

Curr Opin Clin Nutr Metab Care 2016, 19:434–438

Segni e sintomi Vs bioimpedenza

Table 5
Clinical rating and BIA measurement of hydration status in 103 geriatric in-patients at hospital admission.

	Clinical rating	BIA	Concordance
Severe dehydration (AS = 1)	0	0	0
Mild dehydration (AS = 2)	34	5	0
Normal hydration (AS = 3)	60	55	40
Mild hyperhydration (AS = 4)	9	32	5
Severe hyperhydration (AS = 5)	0	11	0
Sum	103	103	45 (43.7%)

AS: analogue scale for the clinical assessment of hydration status.

Roesler et al. : Arch Gerontol Geriatr. 2010 May-Jun;50(3)

Contents lists available at ScienceDirect

Clinical Nutrition

journal homepage: http://www.elsevier.com/locate/clnu

ESPEN Guideline

ESPEN guideline on clinical nutrition and hydration in geriatrics

Dorothee Volkert [a, *], Anne Marie Beck [b], Tommy Cederholm [c], Alfonso Cruz-Jentoft [d], Sabine Goisser [e], Lee Hooper [f], Eva Kiesswetter [a], Marcello Maggio [g, h], Agathe Raynaud-Simon [i], Cornel C. Sieber [a, j], Lubos Sobotka [k], Dieneke van Asselt [l], Rainer Wirth [m], Stephan C. Bischoff [n]

"All older persons should be considered to be at risk of low-intake dehydration and encouraged to consume adequate"

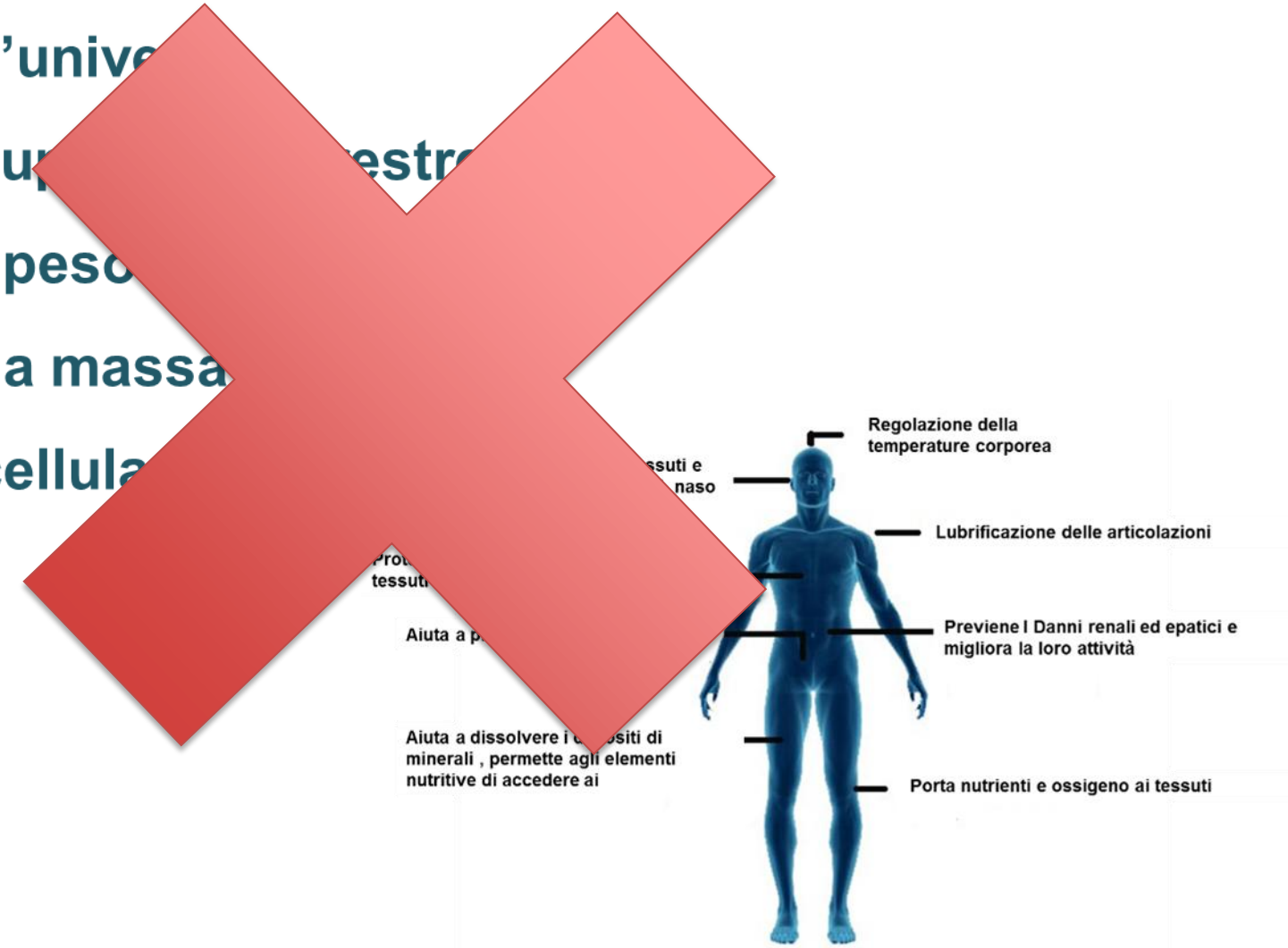
These interventions should be implemented in clinical practice and routinely used

Volkert D, et al., ESPEN guideline on clinical nutrition and hydration in geriatrics, Clinical Nutrition (2018)


EVIDENCE BASED

L’importanza dell’acqua

- 0,001% nell’unive
- 66% della su estr
- 50-70% del peso
- 65-80% della massa
- 90% peso cellula



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Idratazione nella prevenzione primaria

nutrients

MDPI

Review

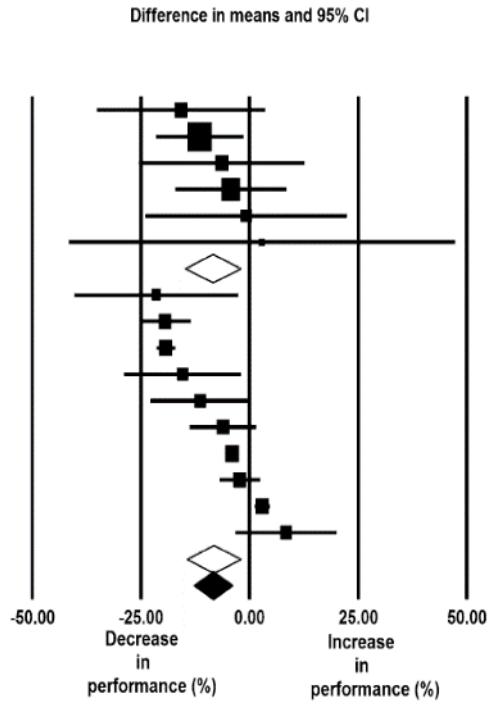
Narrative Review of Hydration and Selected Health Outcomes in the General Population

Table 5. Summary of Literature Findings.

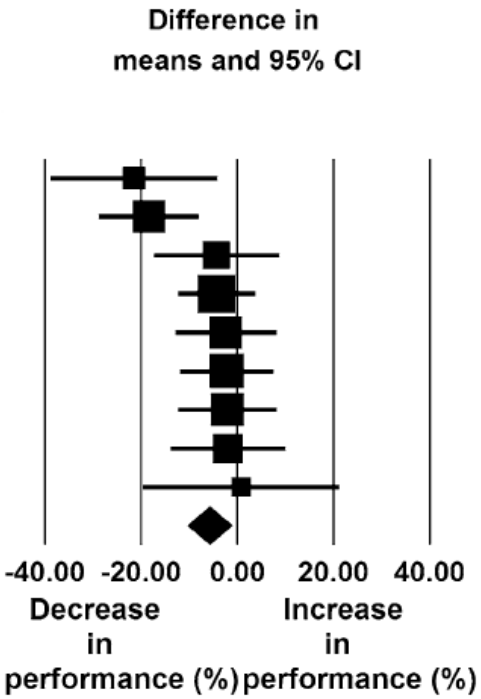
Health Outcomes	Summary of Literature Findings
Skin Health	The effectiveness of additional water consumption on skin barrier function is unclear. A few studies suggest that increasing water consumption may improve the hydration of the stratum corneum layer of the epidermis, which plays a key role in skin barrier function. However, no changes to transepidermal water loss (measure of barrier integrity) were reported.
Cognition +++	Despite variability among study methodologies, dehydration impairs cognitive performance for tasks involving attention, executive function, and motor coordination when water deficits exceed 2% body mass loss. Cognitive domains involving lower order mental processing (e.g., simple reaction time) are less sensitive to changes in hydration status. In children, results from studies on hydration and cognition are mixed.
Mood and Fatigue	Hypohydration is associated with increased negative emotions such as anger, hostility, confusion, depression and tension as well as fatigue and tiredness. These findings are consistent in adults, but unclear and very limited in children.
Headache	The evidence is too limited to determine if hydration affects headache.
Kidney Stones	A significant association between high fluid intake and a lower risk of incident kidney stones has been reported, but data are limited.
Renal Function related to Toxin Elimination	There is not enough evidence to support commercial detox diets for toxin elimination.
Gastrointestinal Function and Constipation ++	Studies on hydration and general gastrointestinal function in healthy people are lacking. Clinical trials have been conducted on constipation, but currently do not support the use of increased fluid intake in the treatment of functional constipation. Further studies are necessary to understand the role of water and fluid consumption in the etiology and treatment of constipation.
Body Weight and Body Composition	Studies on fluid replacement of caloric beverages with non-caloric beverages have consistently resulted in lower energy intake. Existing data suggest that increased water consumption contributes to reductions in body fat and/or weight loss in obese adults, independent of changes in energy intake. Data in children are limited. More studies are needed to clarify the effect in both adults and children.

Nutrients **2019**, 11, 70

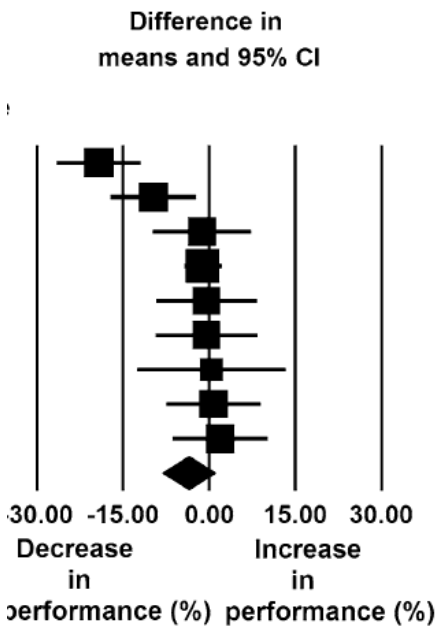
disidratazione nello sportivo: META ANALISI



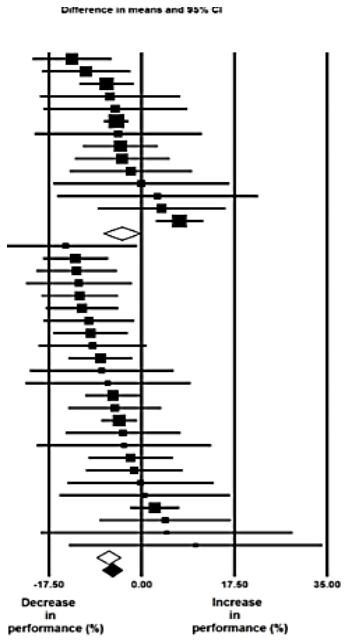
Endurance



Anaerobic Power



Anaerobic capacity



Strenght

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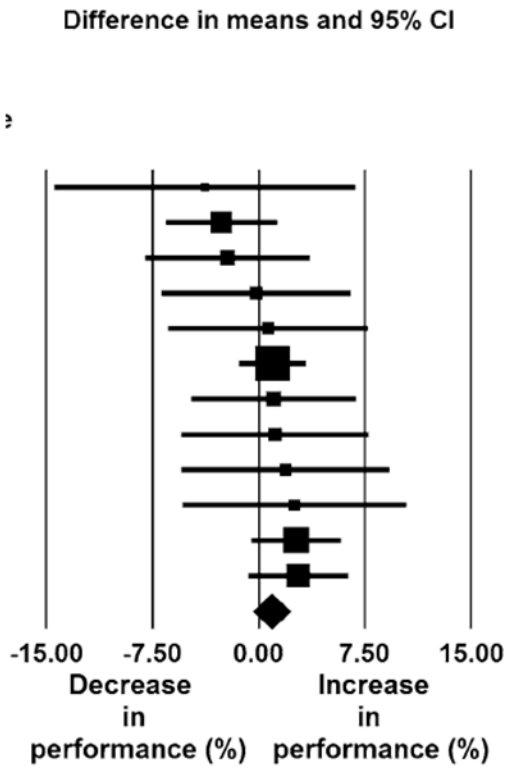
Sports Med. 2015 Aug;45(8):1207-27

DISidratazione funzionale



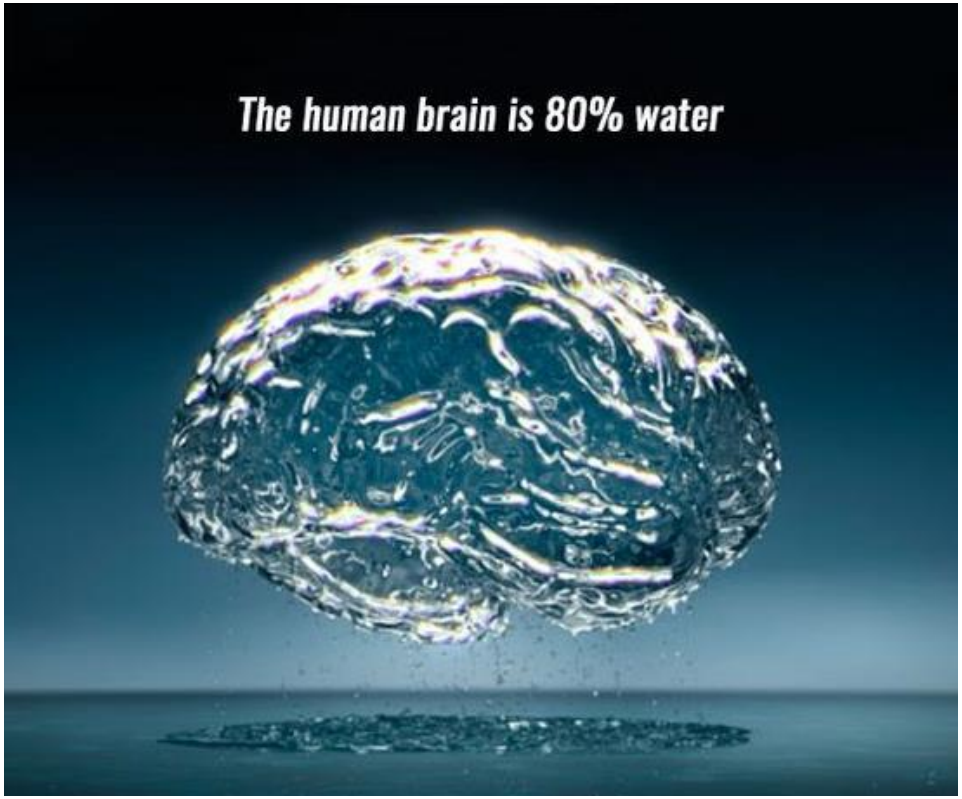
'functional dehydration' could help climb quicker

"And losing 2Kg in a few hours one day in the mountains of the Tour, Froome is capable of ascending Alpe d'Huez 47 seconds quicker than his previous best"

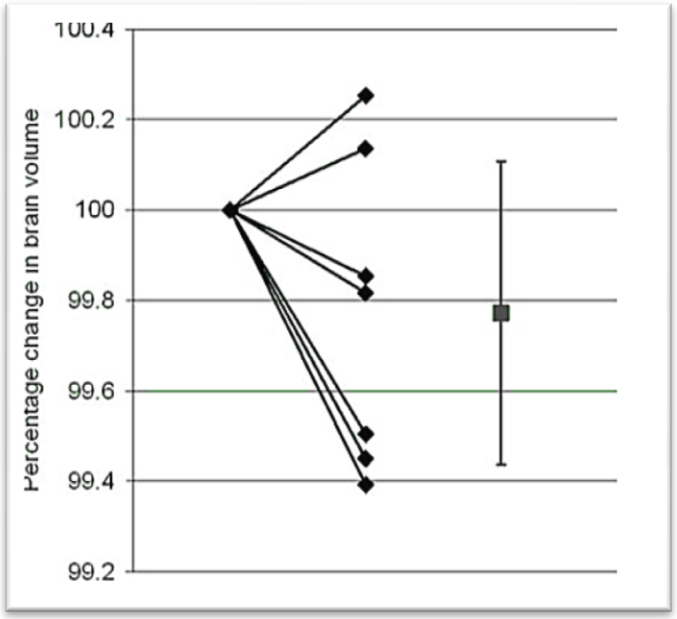
Team Sky doctor Palfreeman

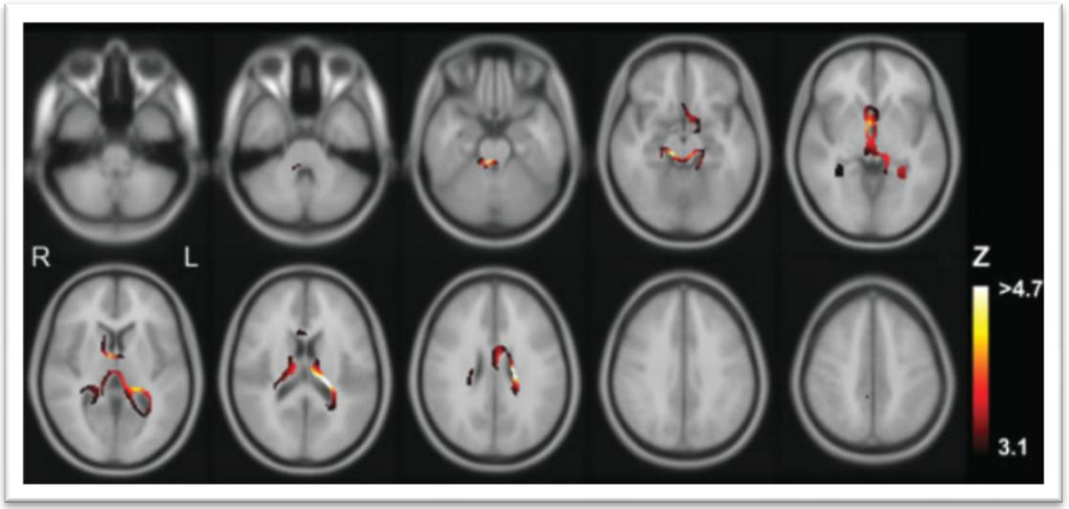
Sports Med. 2015 Aug;45(8):1207-27. doi: 10.1007/s40279-015-0349-0

Idratazione e capacità cognitive



Effetto della disidratazione acuta nel cervello





Global percentage change in brain volume after acute dehydration measured by MRI
(SIENA algorithm)

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Human Brain Mapping 30:291–298 (2009)

disidratazione acuta e morfologia del cervello umano

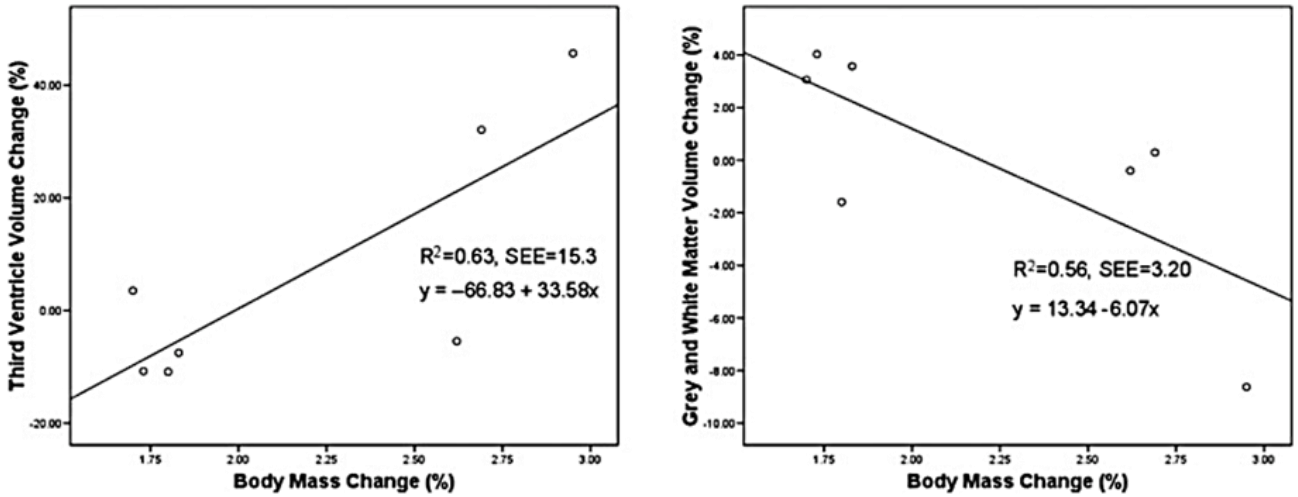
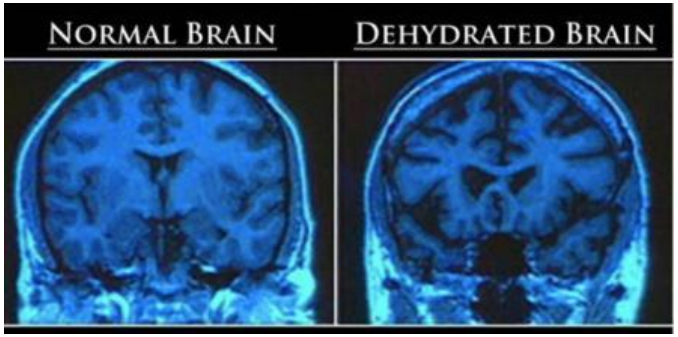


Figure 3.

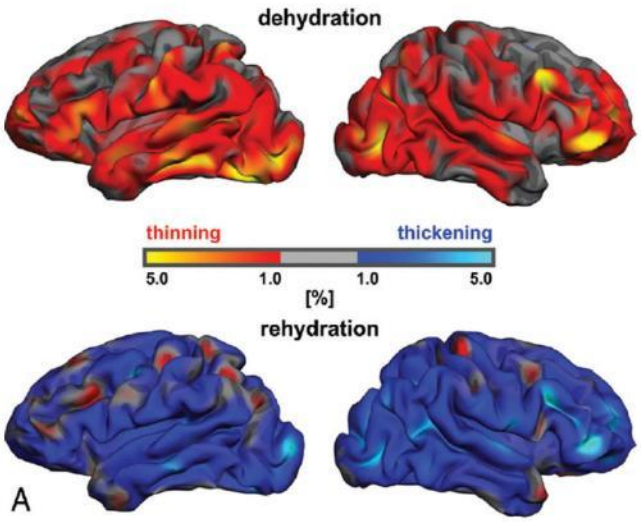
Relationship between change in body weight and anatomical volumes (MEASURE). The left panel shows the relationship between percentage change in body mass and third ventricle volume. The right panel shows the relationship between percentage change in body mass and whole-brain volume. SEE, Standard Error of the Estimate.

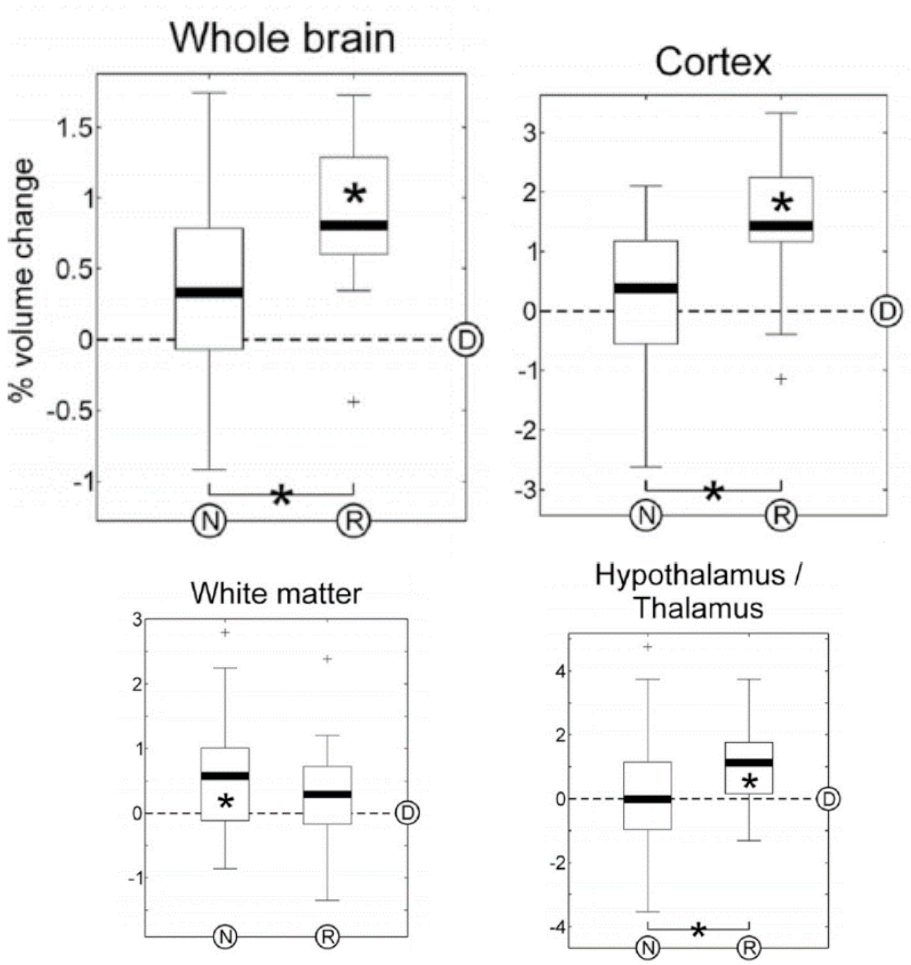


Human Brain Mapping 30:291–298 (2009)

Disidratazione e reidratazione del tessuto celebrale

15 healthy volunteers (6 women, 9 men)
No fluids for 12h
1H-MR Imaging and Spectroscopy

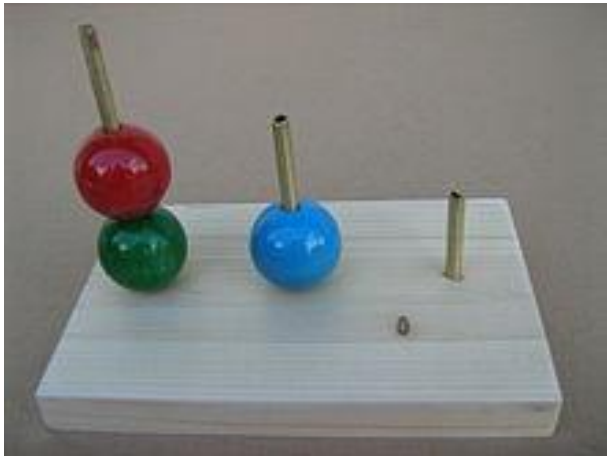


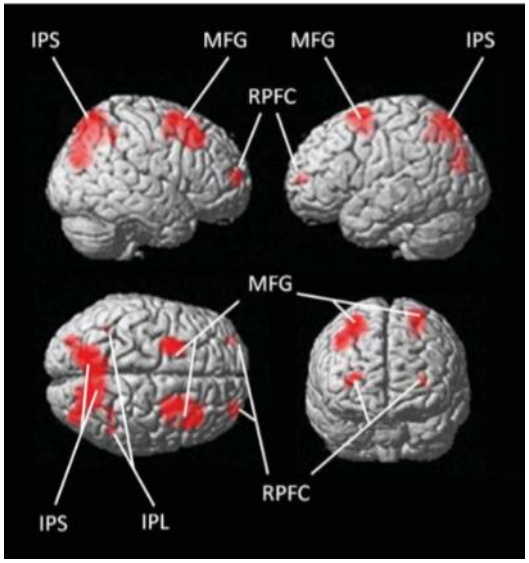


Am J Neuroradiol. 2015 December ; 36(12): 2277–2284

Disidratazione Vs struttura cerebrale e funzionalità

Test della torre di Londra (*Shallice, 1982)*





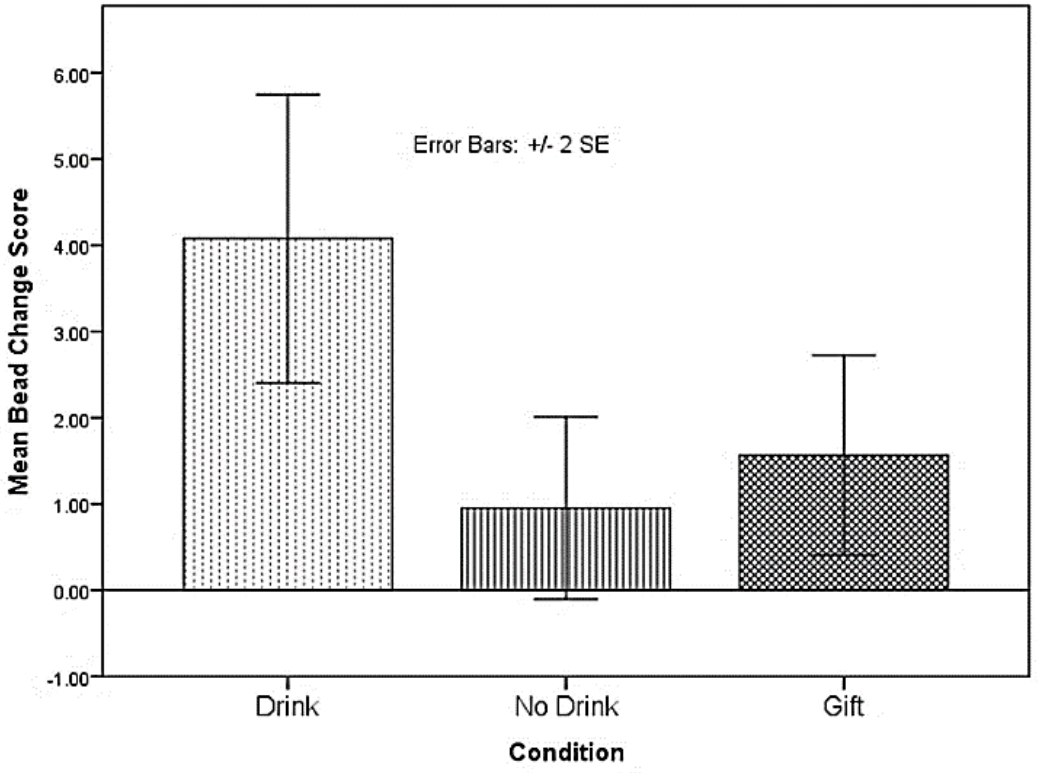
Brain response during the Tower-of-London task.

Given the limited availability of brain metabolic resources, these findings suggest that prolonged states of reduced water intake may adversely impact executive functions such as planning and visuo-spatial processing

Human Brain Mapping 32:71–79 (2011)

Disidratazione Vs funzionalità

Threading Bead Test



adapted from *Psychological research* (2019): 1-12.

Idratazione a scuola: prevenzione

(N= 500)

(67.2%)

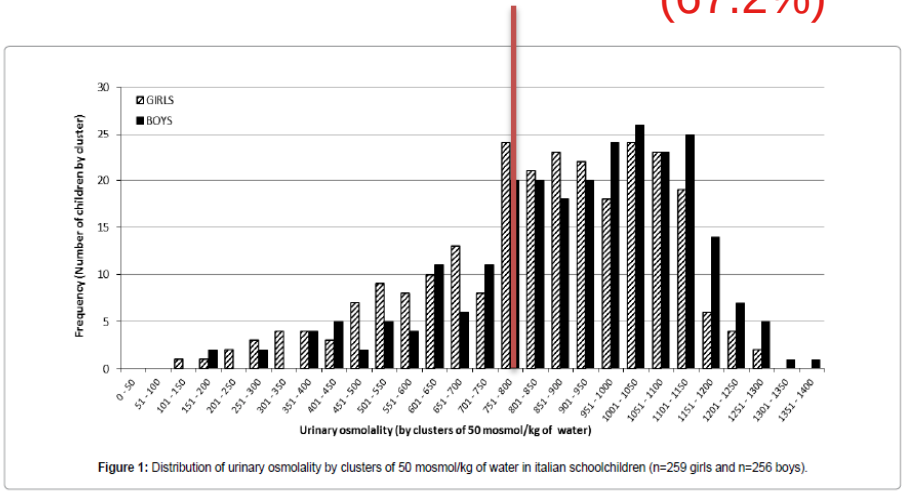


Figure 1: Distribution of urinary osmolality by clusters of 50 mosmol/kg of water in italian schoolchildren (n=259 girls and n=256 boys).

U_{osm} > 800 osmol/Kg

Assael et al., J Nutr Disorders Ther 2012, 2:3

(N= 194)

(71%)

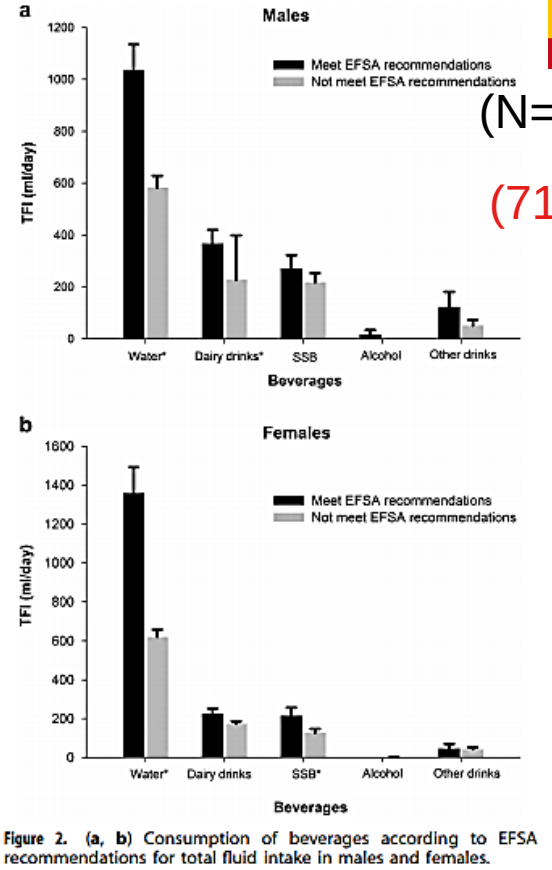


Figure 2. (a, b) Consumption of beverages according to EFSA recommendations for total fluid intake in males and females.

Iglesia et al, EJCN (2015), 1–7

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Idratazione funzionale per weight loss

n = 41; 46-–66 years, BMI 32-36 kg/m^2

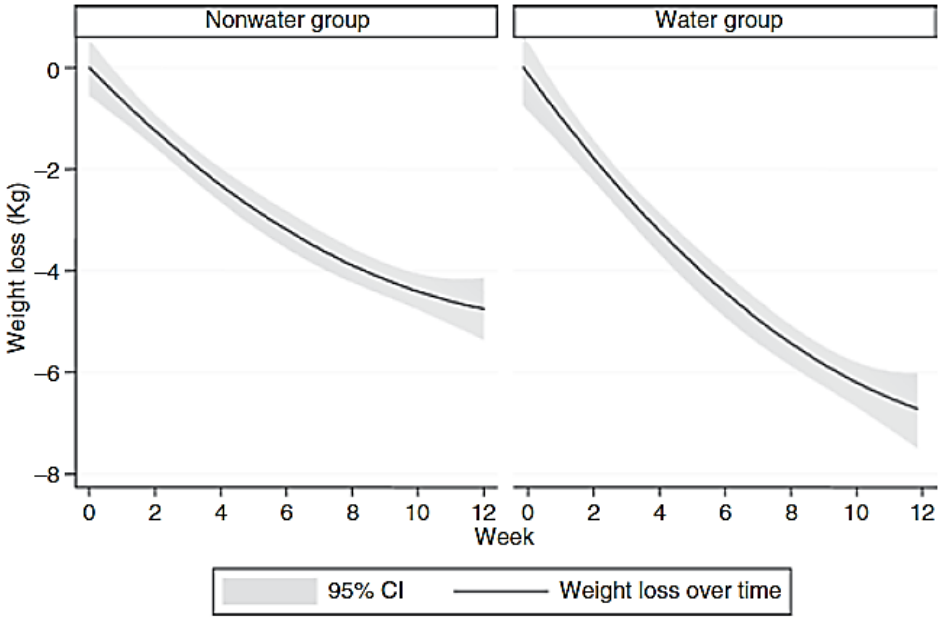
n = 48; 55–75 years, BMI 25–40 kg/m^2

hypocaloric diet + 500 ml water prior to each daily meal
Vs hypocaloric diet only for 12 weeks

TABLE 2 Analyses of weight change between baseline and 12 weeks and mean difference between groups at 12-week follow-up

	Mean weight change from baseline to follow-up		Mean difference between groups at follow-up (unadjusted)
	Comparator	Intervention	
Primary analysis - baseline observation carried forwards, kg (95% CI)	−1.2 (−2.1 to −0.31) (n = 43)	−2.4 (−3.5 to −1.3) (n = 41)	−1.3 (−2.4 to −0.14) P = 0.028 (n = 84)
Available case analysis, kg (95% CI)	−1.3 (−2.3 to −0.35) (n = 38)	−2.5 (−3.6 to −1.4) (n = 39)	−1.15 (−2.4 to 0.08) P = 0.066 (n = 77)

Obesity (2015) 23, 1785–1791. doi:10.1002/oby.21167



Obesity (2010) **18,** 300–307. doi:10.1038/oby.2009.235

Aggiungendo 500 ml ad ogni pasto si ottiene un aumento di WL
da -1,3 Kg a 2,5 Kg

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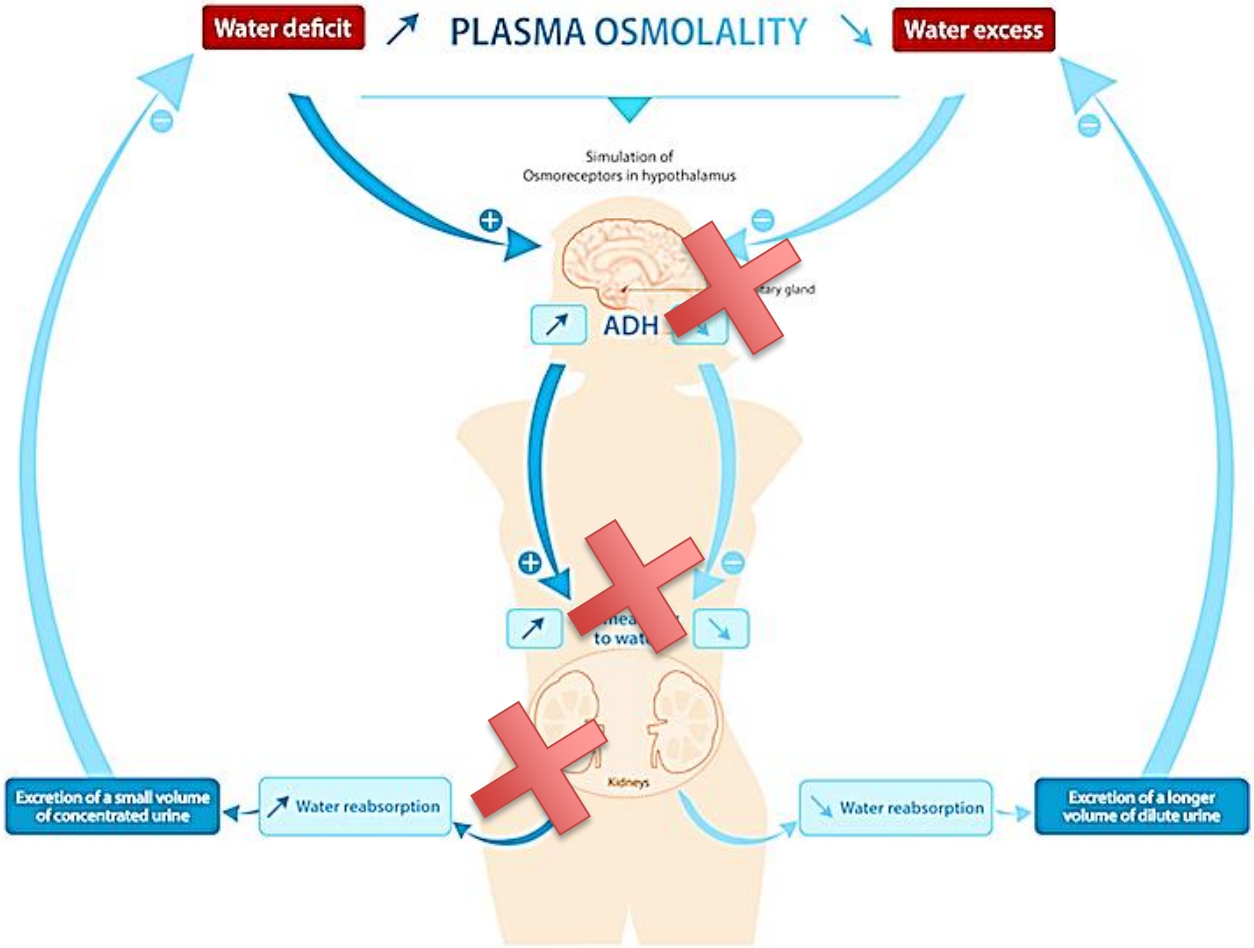
Idratazione del soggetto patologico



Clinica e idratazione

Iperidratazione Vs segni clinici

Variable	Sensitivity (%)	Specificity (%)
Medical history:		
Chronic heart failure	62	87
Myocardial infarction	43	87
Hypertension	72	48
Clinical findings:		
Orthopnea	66	57
Jugular venous distention	38	90
S3 gallop rhythm	13	93
Rales	59	77
Lower extremity edema	64	74

	Sensitivity	Specificity	Predictive value		Accuracy
			Positive	Negative	
Physical findings					
Rales	48	91	92	62	70
Edema	52	96	100	65	74
S3	13	96	100	51	54
Ultrasonogram					
Pleural effusion	74	83	85	73	78

Abbreviations: BNP, brain natriuretic peptide; S3, third heart sound.

J Am Med Dir Assoc 2008; 9: 292–301)

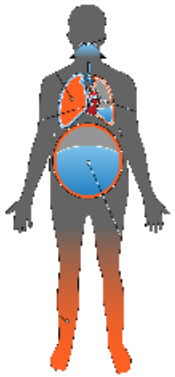
Circ Heart Fail. 2016;9:e002922.

Iperidratazione Vs segni clinici

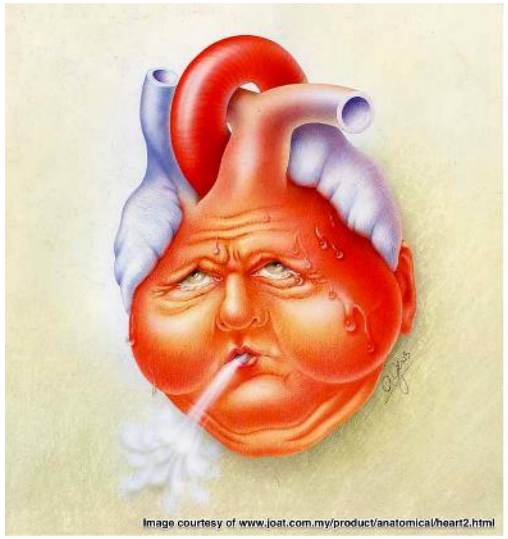
Skin, eyes, and mucous membranes	Eaton et al,[33] 1994	A	Dry axilla	50	82	2.8 (1.4-5.4)	0.6 (0.4-1.0)
	Gross et al,[34] 1992	B	Mucous membranes of mouth and nose dry	85	58	2.0 (1.0-4.0)	0.3 (0.1-0.6)
	Gross et al,[34] 1992	B	Tongue dry	59	73	2.1 (0.8-5.8)	0.6 (0.3-1.0)
	Gross et al,[34] 1992	B	Longitudinal furrows on tongue	85	58	2.0 (1.0-4.0)	0.3 (0.1-0.6)
	Gross et al,[34] 1992	B	Sunken eyes	62	82	3.4 (1.0-12.2)	0.5 (0.3-0.7)
Neurological findings	Gross et al,[34] 1992	B	Confusion present	57	73	2.1 (0.8-5.7)	0.6 (0.4-1.0)
	Gross et al,[34] 1992	B	Upper or lower extremity weakness present	43	82	2.3 (0.6-8.6)	0.7 (0.5-1.0)
	Gross et al,[34] 1992	B	Speech not clear or expressive	56	82	3.1 (0.9-11.1)	0.5 (0.4-0.8)
Capillary refill time	Schriger and Baraff,[36] 1991	C	Capillary refill time greater than age- and sex-specific upper normal limit (see "Results")	34	95	6.9 (3.2-14.9)	0.7 (0.5-0.9)

*LR indicates likelihood ratio; CI, confidence interval. See Table 2 footnotes for grading determinations.

JAMA, March 17, 1999—Vol 281, No. 11 **1027**



Idratazione nelle patologie croniche severe



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Fluidi in scompenso cardiaco (acuto e congestizio)

Clinical profile at presentation	ADHERE (n=110 000)	Euro-HF (n=11 000)	OPTIMIZE-HF (n=48 612)
Mean systolic blood pressure, mm Hg	145	133	142
Systolic blood pressure >140 mm Hg, %	50	29	48
Dyspnea at rest, %	34	40	44
Dyspnea on exertion, %	89	35	61
Rales, %	67	...	64
Jugular venous distension, %	...	...	28
Peripheral edema, %	**66**	**20**	**65**
Outcomes			
HF symptoms at discharge, %			
Unchanged/worse	<1	...	<3
Better (symptomatic)	40	...	42
Better (asymptomatic)	50	...	50
>2 kg weight loss at discharge, %	50	...	50

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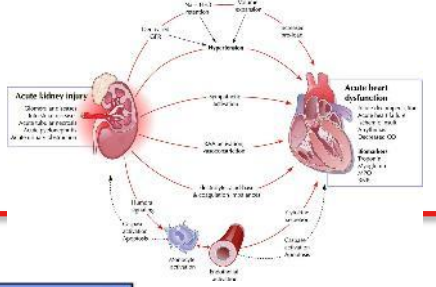
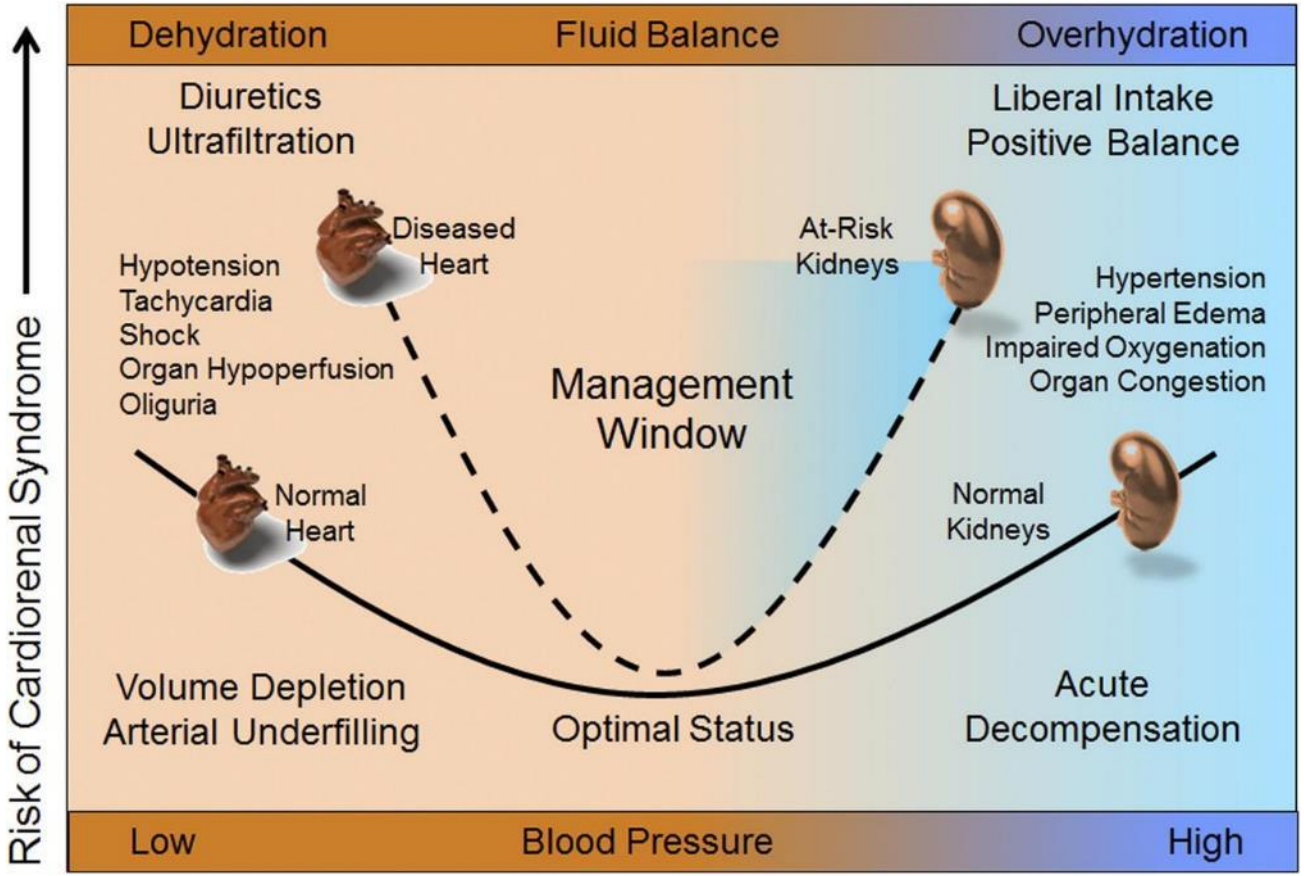
Gheorghiade M, et al. Circulation 2005;112:3958-68

Sindrome cardiorenale: idratazione funzionale





Ronco et al. J Am Coll Cardiol. 2012;60:1031-42

Idratazione predice la LOS in pazienti AHF

A total of 706 patients (367 male; mean age: 78 ± 10 y)

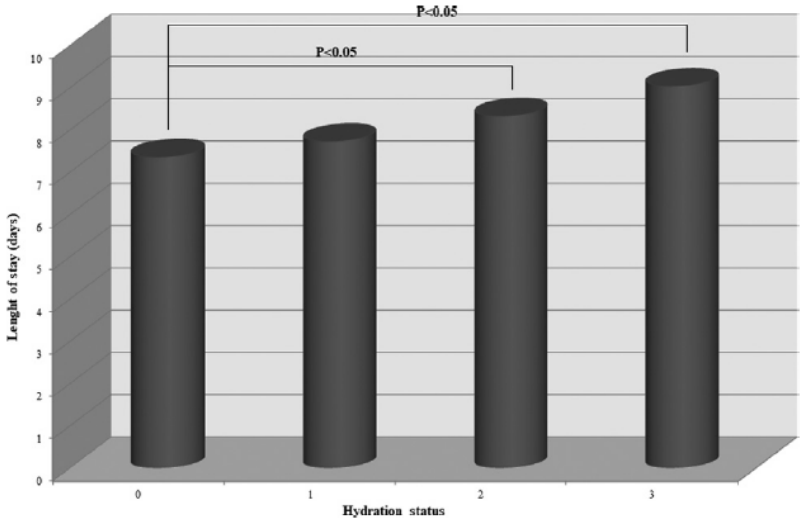


Fig. 1. Relationship between hydration status and length of stay (LOS). Data represented as median. Hydration index mean ranges: 0, normohydration: 72.8–74.2%; 1, mild hyperhydration: 74.3–81%; 2, moderate hyperhydration: 81.1–87%; 3, severe hyperhydration: 87.1–100%.

Table 4
Univariate and multivariate regression analysis: the role of clinical, instrumental and biochemical variables on length of stay

	Univariate model		Multivariate model	
Variables	Beta	Significance	Beta	Significance
BNP (pg/mL)	0.250	**0.000**	0.178	**0.000**
NYHA class	0.153	**0.000**	0.064	0.106
BUN (mg/dL)	0.183	**0.000**	0.102	**0.011**
Hemoglobin (g/dL)	-0.176	**0.000**	−0.072	0.077
Hydration index (%)	0.267	**0.000**	**0.183**	**0.000**
Peripheral edema	0.102	**0.019**	−0.010	0.821

F. Massari et al. / Nutrition 61 (2019): 56-60

+ 1,7 gg degenza per iperidratazione
X 900 euro/gg **
X 190,000 pts/aa
---
3 Mld di euro

European Journal of Heart Failure (2014) **16, 729–736

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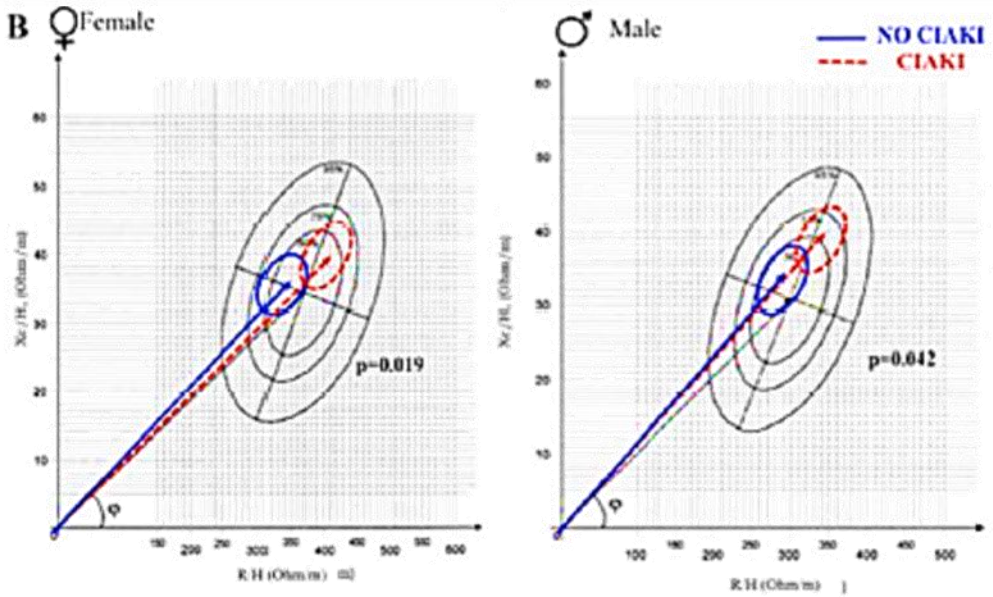
Idratazione e danni renali da coronarografia

N=900 CAD Pts with contrast iodixanol

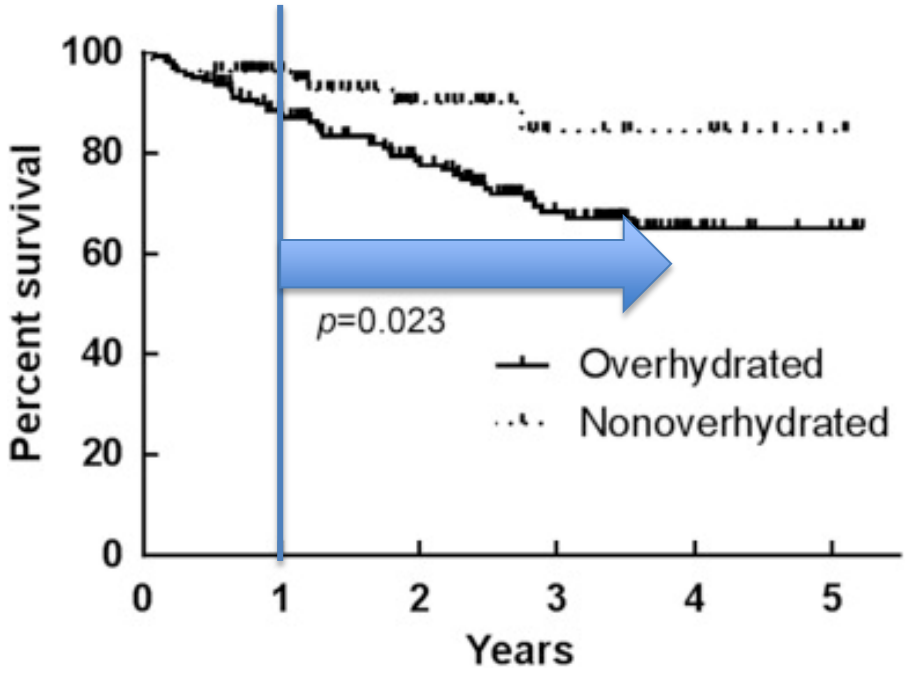


Conclusions: **Lower fluid status evaluated by BIVA immediately before contrast medium administration resulted a significant and independent predictor of CI-AKI in stable CAD** patients. This simple non-invasive analysis should be tested in guiding tailored volume repletion

Maioli, Mauro, et al. "Pre-procedural bioimpedance vectorial analysis of fluid status and prediction of contrast-induced acute kidney injury." Journal of the American College of Cardiology 63.14 (2014): 1387-1394.

Idratazione predice sopravvivenza in pazienti CKD

43 patients (CKD-S: 3-4)
4 years follow-up



Kaplan-Meier survival curve of two groups for all-cause mortality. Median follow-up duration was 24.0 months. During the follow-up period, 43 patients (26.9%) from the overhydrated group(OG) and 7 patients (8.8%) from the non-overhydrated group (NOG)

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Ye Jin Kim, Kidney Research and Clinical Practice, 2015, 212–218

Idratazione palliative oncologiche

90 patients
BIVA scored hydration assessment
Morita hydration scored
ECOG= 3/4

Table 4. Classification of hydration as a three-item scale according to the RXC graph scale.

Hydration status	Male	Female	Total (%)
Normal	18	25	43 (47.8)
'Less hydrated'	7	3	10 (11.1)
'More hydrated'	17	20	37 (41.1)
Total	42	48	90

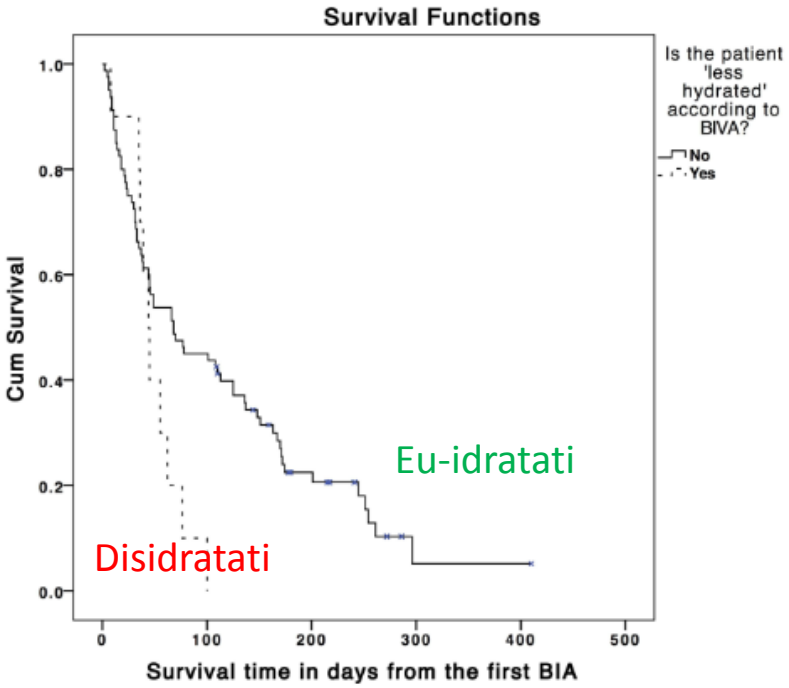

Fig 5. Kaplan-Meier graph showing survival time in days according to the 'less hydrated' classification (χ^2 = 4.08, P = 0.04). Tick marks indicate censoring of data.

doi:10.1371/journal.pone.0163114.g005

"In advanced cancer, hydration status was associated with clinical signs and symptoms. *Hydration status and pre-renal failure were independent predictors of survival"*

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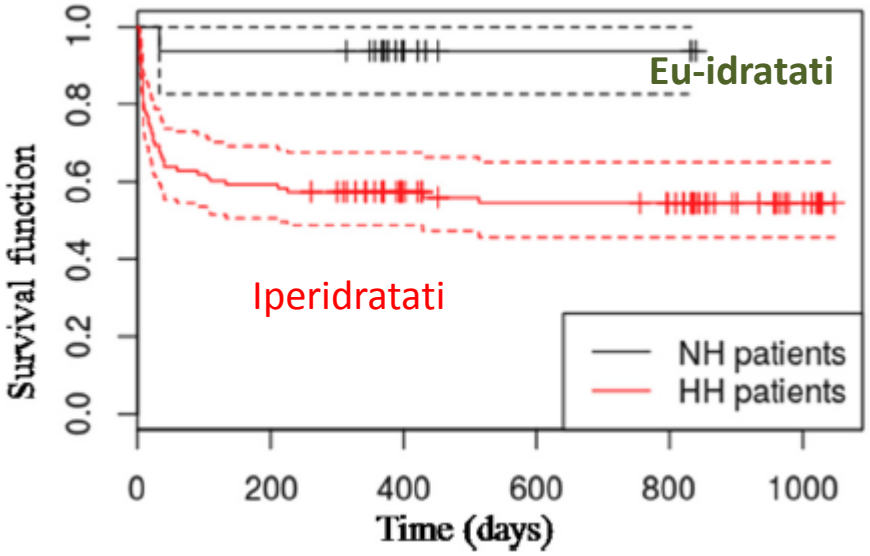
Nwosu, Amara Callistus, et al. " *PloS one* 11.9 (2016): e0163114.

Bilancio idrico Vs idratazione: mortalità in terapia intensiva

125 Pts (AKI, CRRT, Septic shock)
515 Biva tests



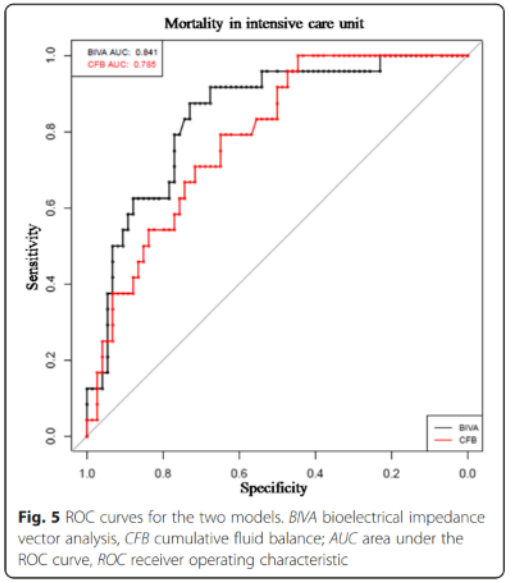


Fig. 5 ROC curves for the two models. *BIVA* bioelectrical impedance vector analysis, *CFB* cumulative fluid balance; *AUC* area under the ROC curve, *ROC* receiver operating characteristic

Severe hyperhydration measured by BIVA was the only variable found to be significantly associated with ICU mortality, when compared to CFB recording.

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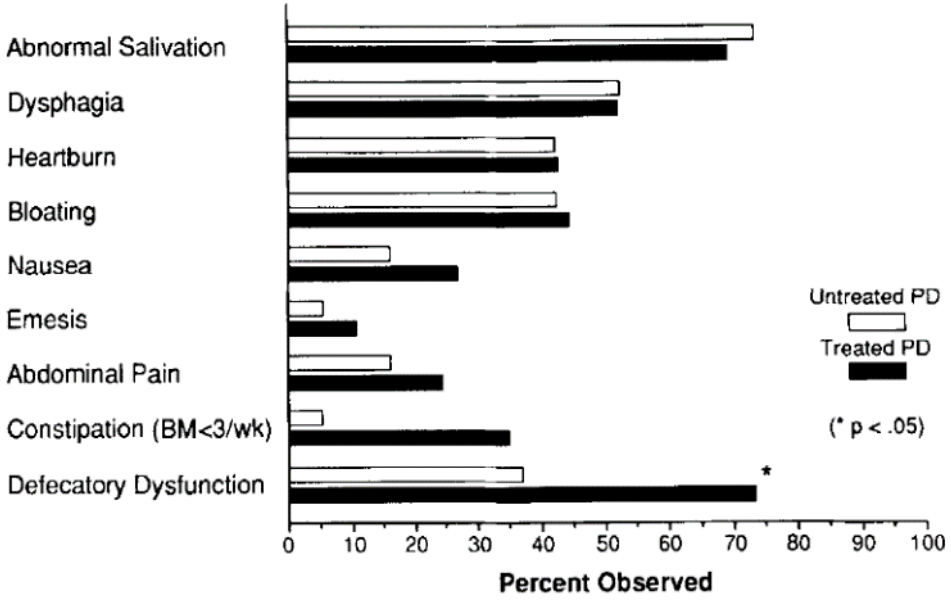
Samoni et al. Critical Care (2016) 20:95

Idratazione nel paziente Parkinson



Edwards LL, Pfeiffer RF, Quigley EM, Hofman R, Balluff M. Gastrointestinal symptoms in Parkinson's disease. Mov Disord 1991; 6:151–156

30- 50% PD patients have orthostatic hypotension

Anti-Parkinson drugs suppress thirst

conspitation prevalence > 70%

FLUIDS therapy

dO Pandya, Mayur, and MONIQUE L. GIROUX. "Parkinson disease: not just a movement disorder." Cleveland Clinic Journal of Medicine 75.12 (2008): 857.

TAKE HOME MESSAGEs

Bilancio fluidi : diario alimentare + urina + sweat rate

Esami elettroliti, P_{osm} (per il baseline) ; [Na+]; U_{osm}

Bioimpedenza vettoriale (BIVA)

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TAKE HOME MESSAGEs