



## Sodium tissulaire et ( hémo)dialyse-<sup>23</sup> Na IRM

**De Mul Aurélie**

Service de Néphrologie, Dialyse, Hypertension et Exploration Fonctionnelle Rénale  
Hospices civils de Lyon

*(Merci Pr Sandrine Lemoine)*



**HCL**  
HOSPICES CIVILS  
DE LYON

# RÉGULATION DE L'HOMÉOSTASIE HYDRO-SODÉE EN HD

Un challenge.....

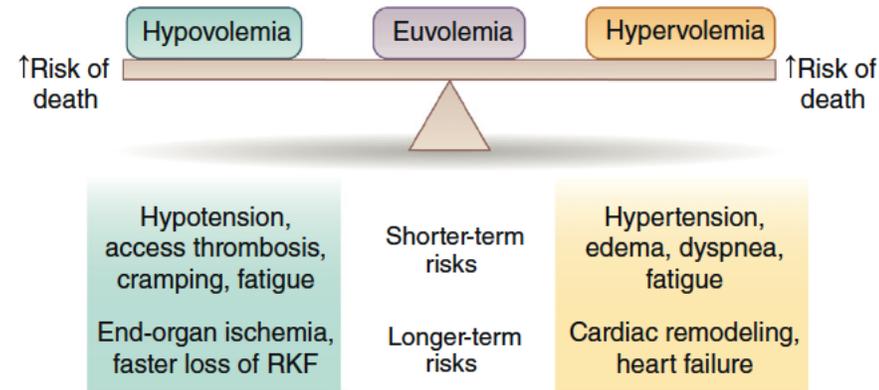


## Blood pressure and volume management in dialysis: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference

Check for updates

OPEN

Jennifer E. Flythe<sup>1,2</sup>, Tara I. Chang<sup>3</sup>, Martin P. Gallagher<sup>4,5</sup>, Elizabeth Lindley<sup>6</sup>, Magdalena Madero<sup>7</sup>, Pantelis A. Sarafidis<sup>8</sup>, Mark L. Unruh<sup>9</sup>, Angela Yee-Moon Wang<sup>10</sup>, Daniel E. Weiner<sup>11</sup>, Michael Cheung<sup>12</sup>, Michel Jadoul<sup>13</sup>, Wolfgang C. Winkelmayer<sup>14</sup> and Kevan R. Polkinghorne<sup>15,16,17</sup>; for Conference Participants<sup>18</sup>



*Flythe et al, Kidney international, 2020*

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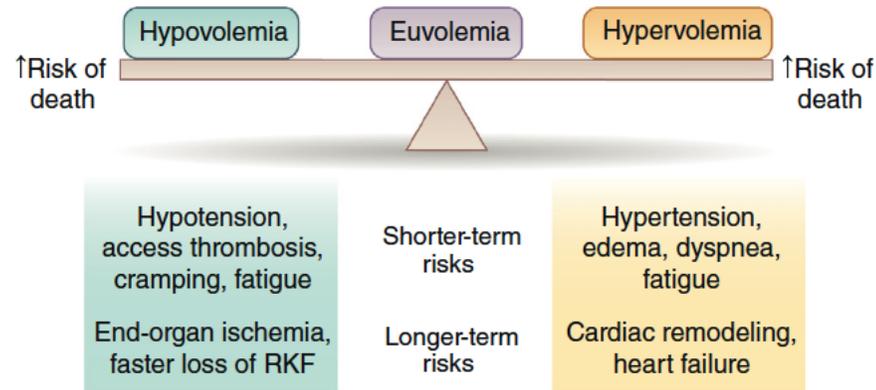


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Toxicité volo-dépendante et volo-indépendante du sodium

*Flythe et al, Kidney international, 2020*

Inflammation

Résistance à l'insuline

Malnutrition

Fonction endothéliale et vasculaire

# RÉGULATION DE L'HOMÉOSTASIE HYDRO-SODÉE EN HD

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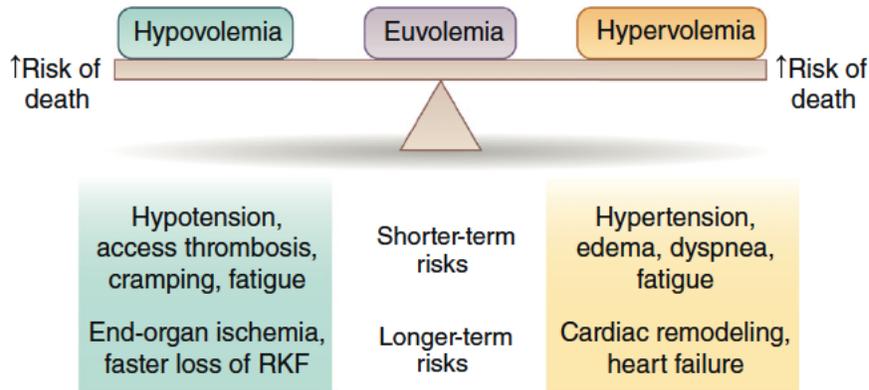
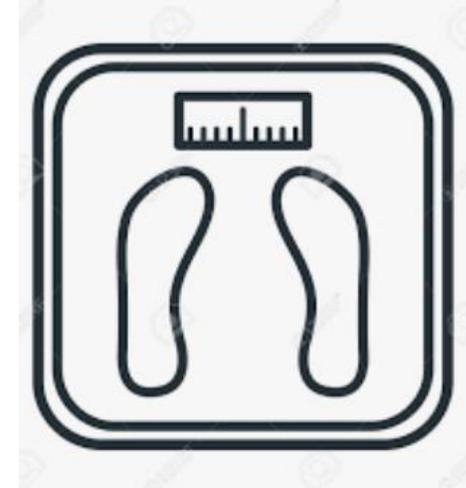


**Blood pressure and volume management in dialysis: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference**

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Poids sec  
OMI  
Pression artérielle



Toxicité volo-dépendante et volo-indépendante du sodium

*Flythe et al, Kidney international, 2020*

VRS  
Impedancemétrie  
Echo pulmonaire  
VCI  
RX thorax  
Biomarqueurs



Nouveaux outils? <sup>23</sup>Na IRM?

# RÉGULATION DE L'HOMÉOSTASIE HYDRO-SODÉE EN HD

Un challenge...

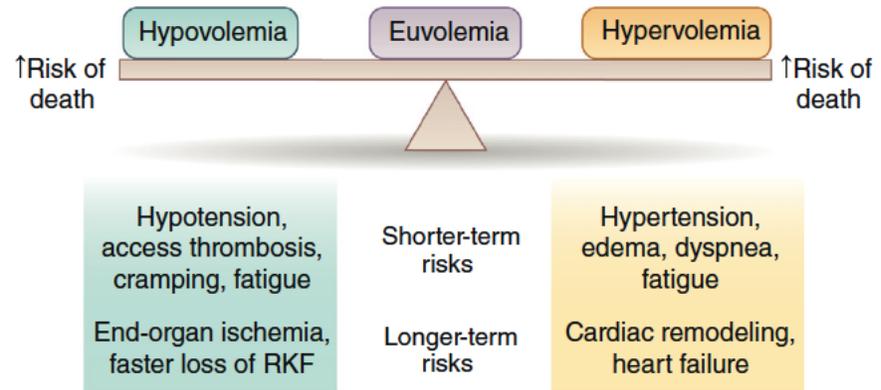
- ✓ Limiter la consommation en eau et en sel
  - ✓ Adhérence
  - ✓ Apports par les traitements
- ✓ Préservation diurèse résiduelle
- ✓ Ultrafiltration
- ✓ Prescription dialysat en sodium

KDIGO: Pas de consensus sur la prescription du sodium en dialyse

**Blood pressure and volume management in dialysis: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference**



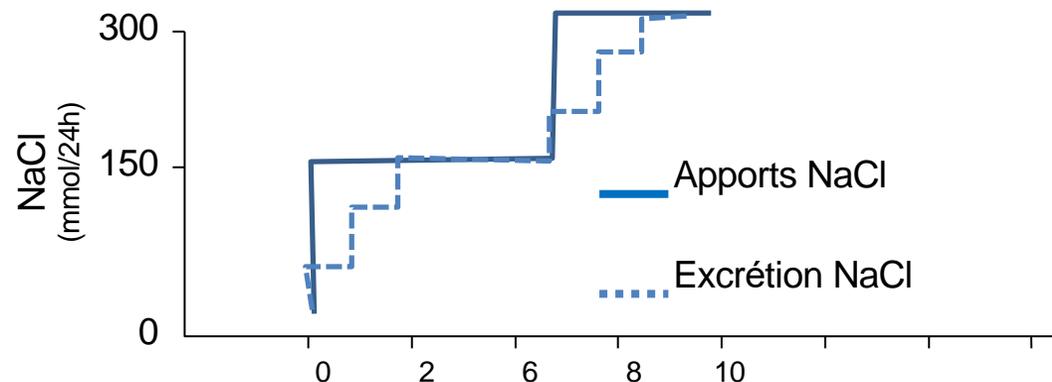
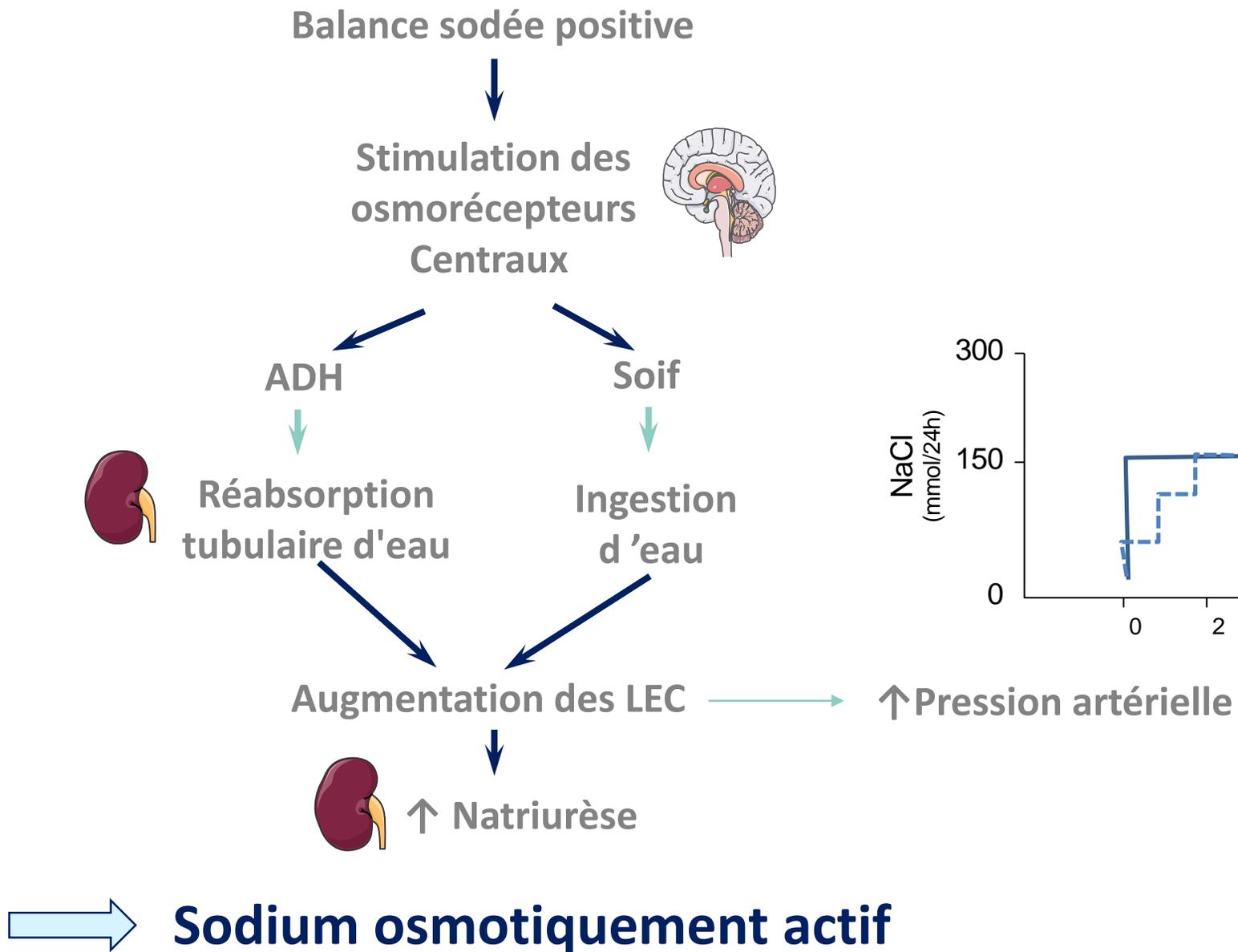
Jennifer E. Flythe<sup>1,2</sup>, Tara I. Chang<sup>3</sup>, Martin P. Gallagher<sup>4,5</sup>, Elizabeth Lindley<sup>6</sup>, Magdalena Madero<sup>7</sup>, Pantelis A. Sarafidis<sup>8</sup>, Mark L. Unruh<sup>9</sup>, Angela Yee-Moon Wang<sup>10</sup>, Daniel E. Weiner<sup>11</sup>, Michael Cheung<sup>12</sup>, Michel Jadoul<sup>13</sup>, Wolfgang C. Winkelmayer<sup>14</sup> and Kevan R. Polkinghorne<sup>15,16,17</sup>; for Conference Participants<sup>18</sup>



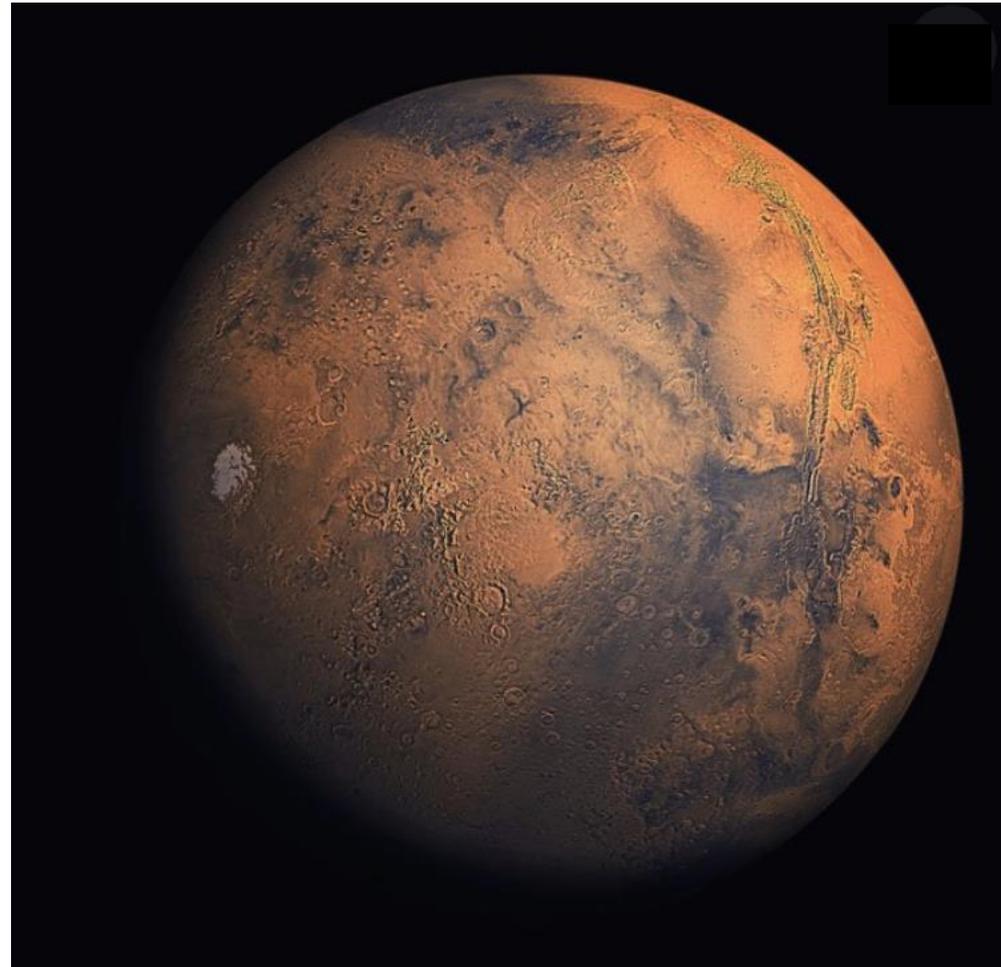
Toxicité volo-dépendante et volo-indépendante du sodium

*Flythe et al, Kidney international, 2020*

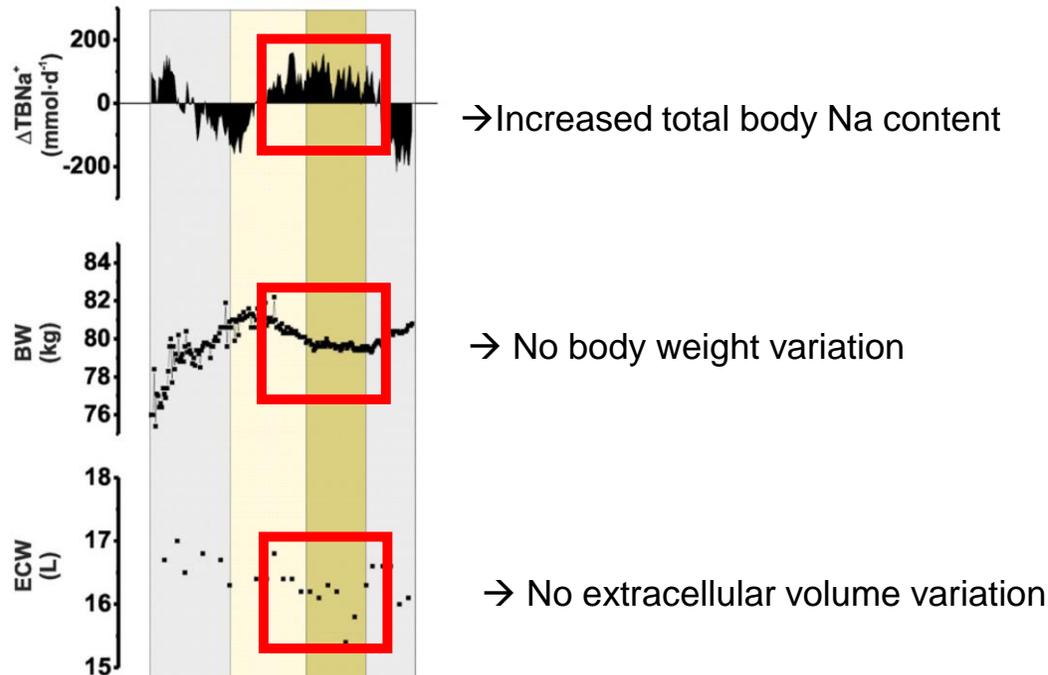
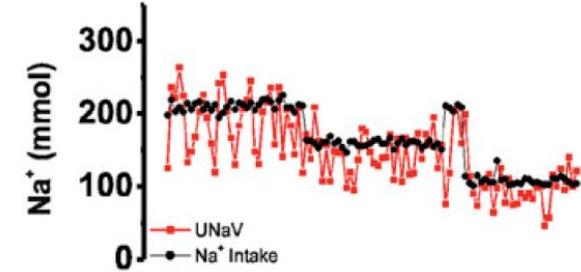
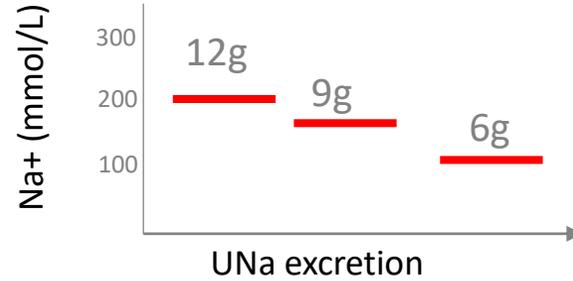
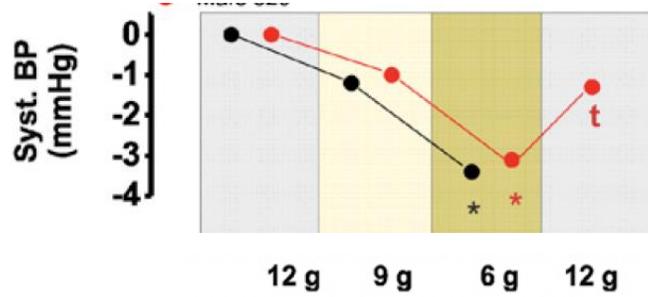
# PHYSIOLOGIE DU SODIUM ET LA THÉORIE DE GUYTON



# DE L'EXPLORATION MARTIENNE AU SODIUM TISSULAIRE

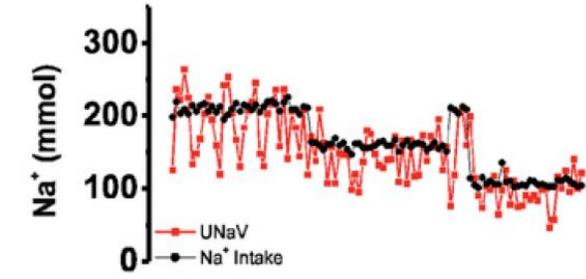
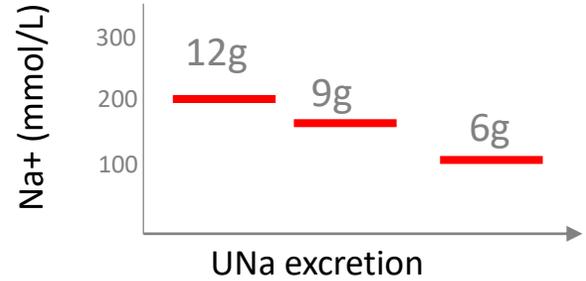
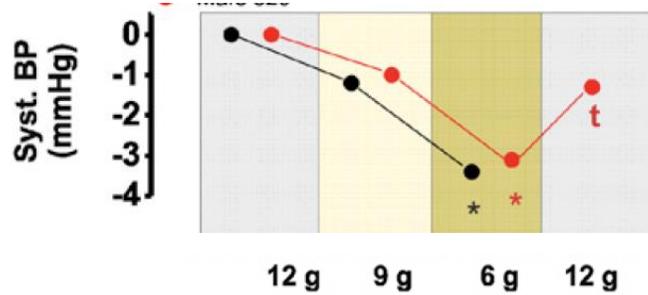


# PHYSIOLOGIE DU SODIUM: EVOLUTION DU CONCEPT?



→ Non osmotically active Na

# PHYSIOLOGIE DU SODIUM: EVOLUTION DU CONCEPT?



Low or high NaCl diet during 8 weeks  
Desiccation and dry ashing

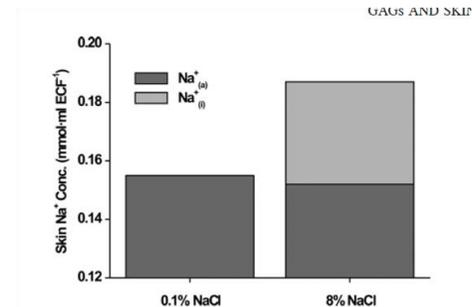
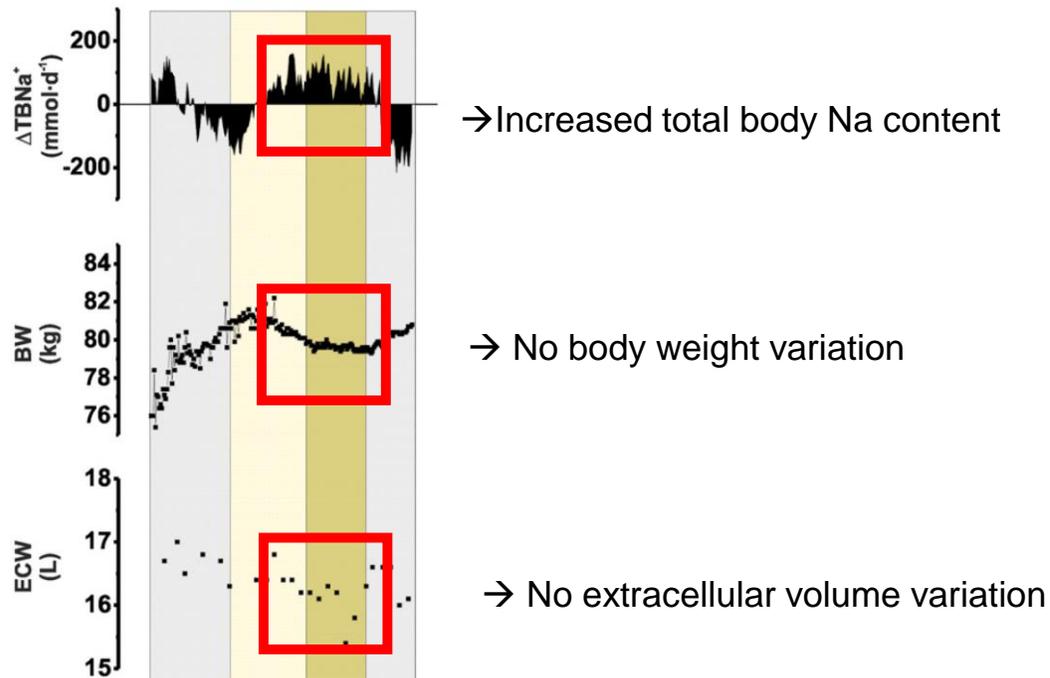


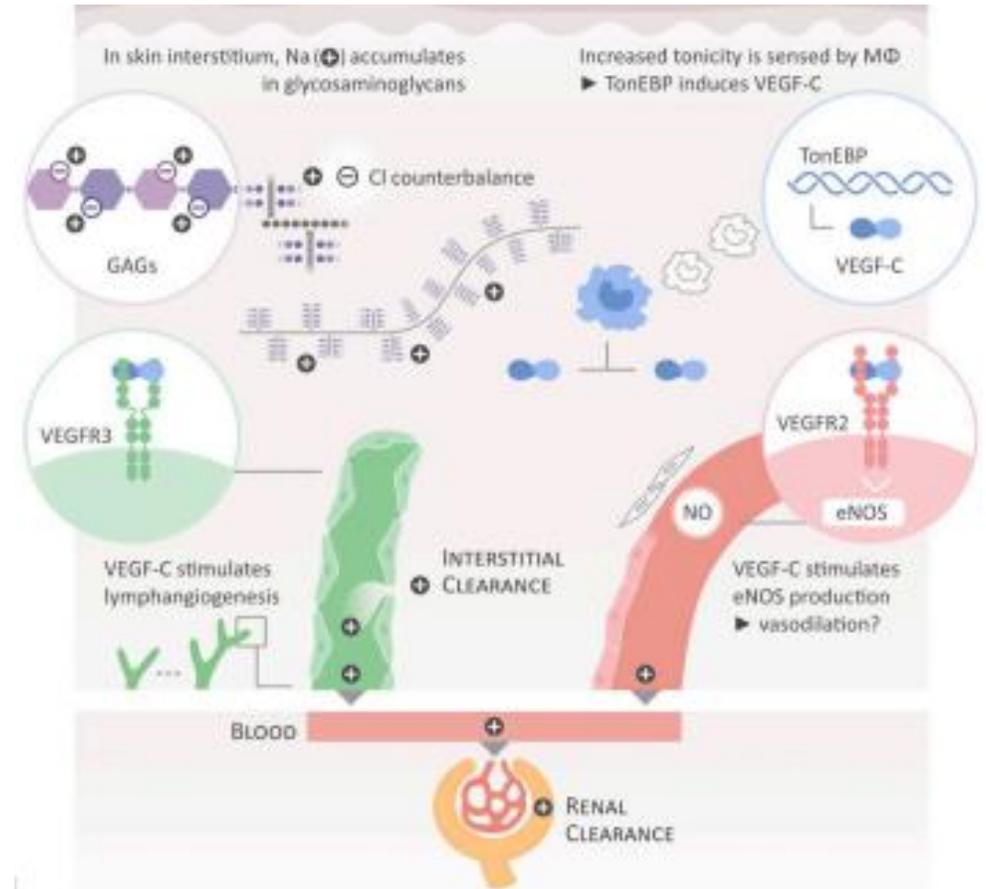
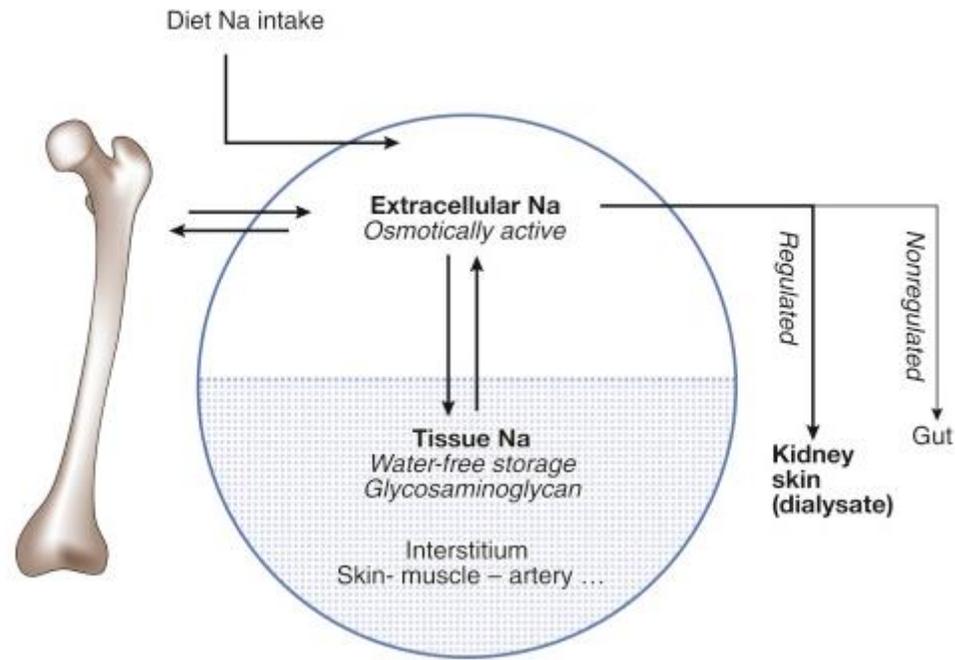
Fig. 1. Estimated extracellular skin Na<sup>+</sup> concentration in female Sprague-Dawley rats fed 0.1% or 8% NaCl for 8 consecutive wk. Na<sup>+</sup><sub>(a)</sub>, osmotically active Na<sup>+</sup>; Na<sup>+</sup><sub>(i)</sub>, osmotically inactive Na<sup>+</sup>; ECF, extracellular fluid.

Titze, renal AJP, 2003; Titze renal AJP, 2004

→ Non osmotically active Na

Rakova, cell metabolism, 2013, Titze, renal AJP, 2008

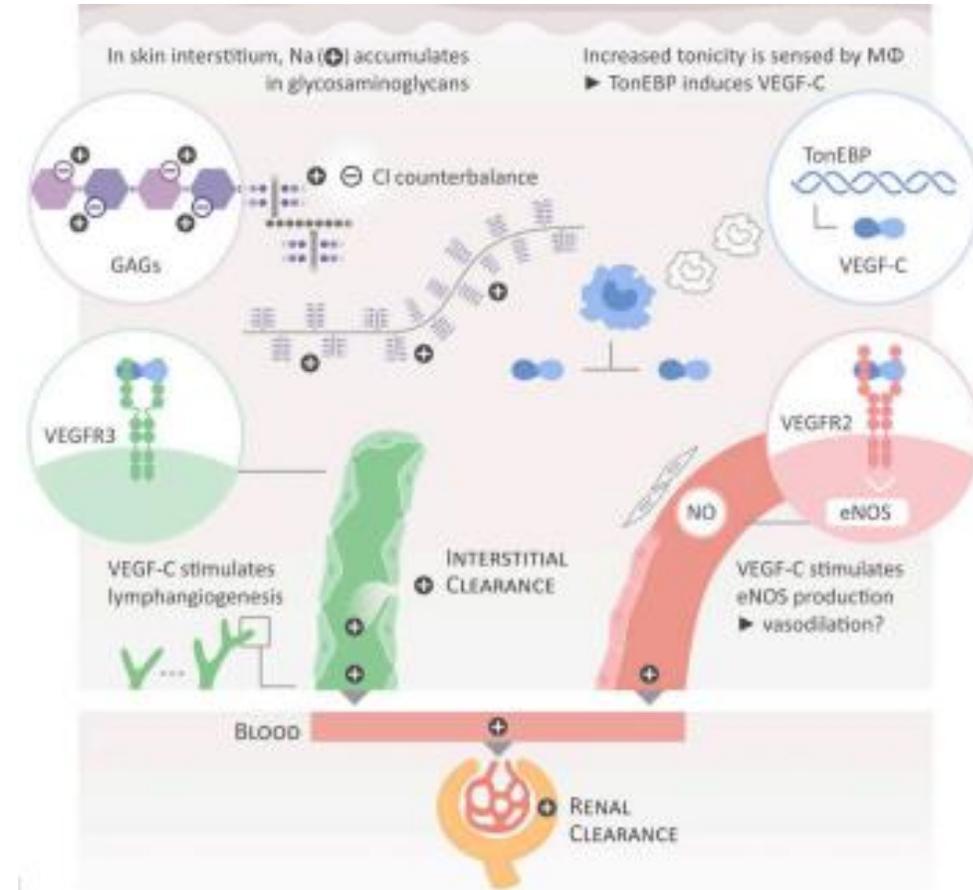
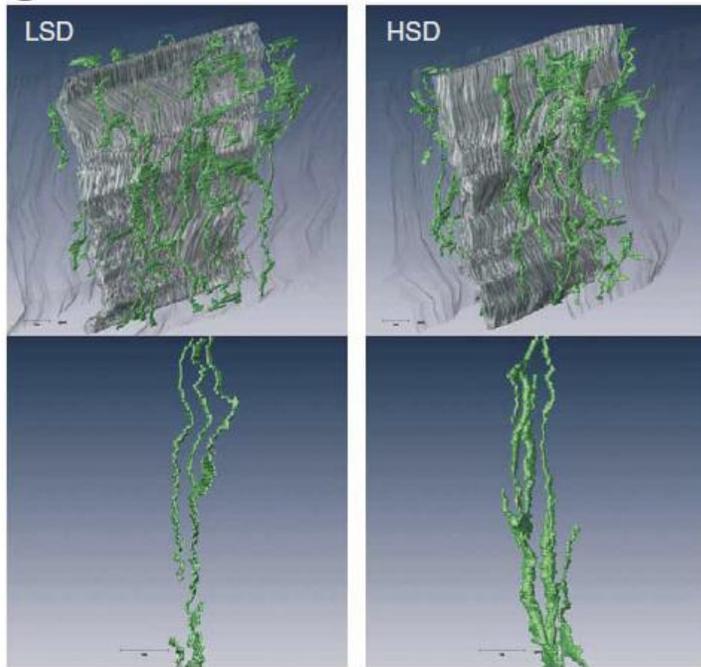
# PHYSIOLOGIE DU SODIUM: EVOLUTION DU CONCEPT?



Canaud B et Al, KI 2019

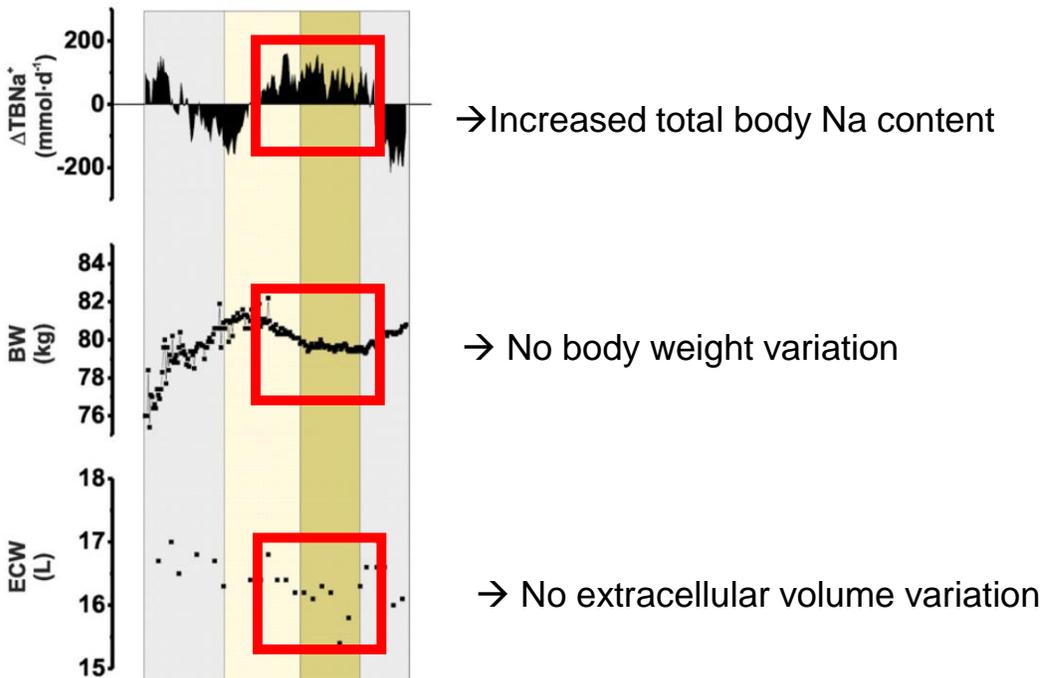
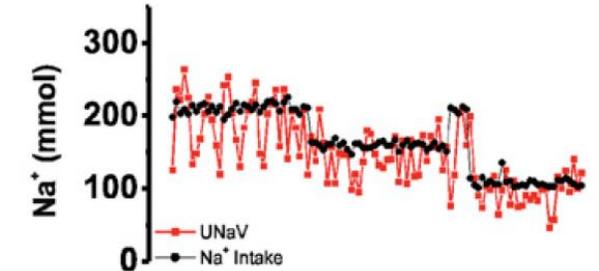
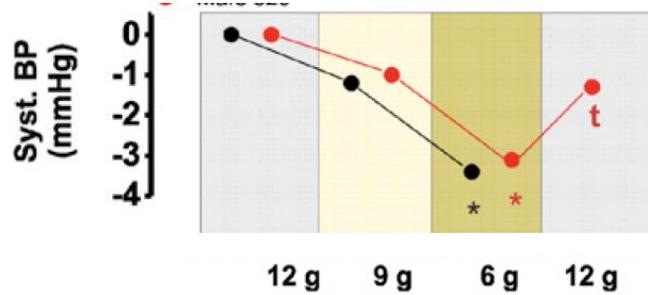
# PHYSIOLOGIE DU SODIUM: EVOLUTION DU CONCEPT?

Régime riche en sodium augmente la densité des capillaires lymphatique

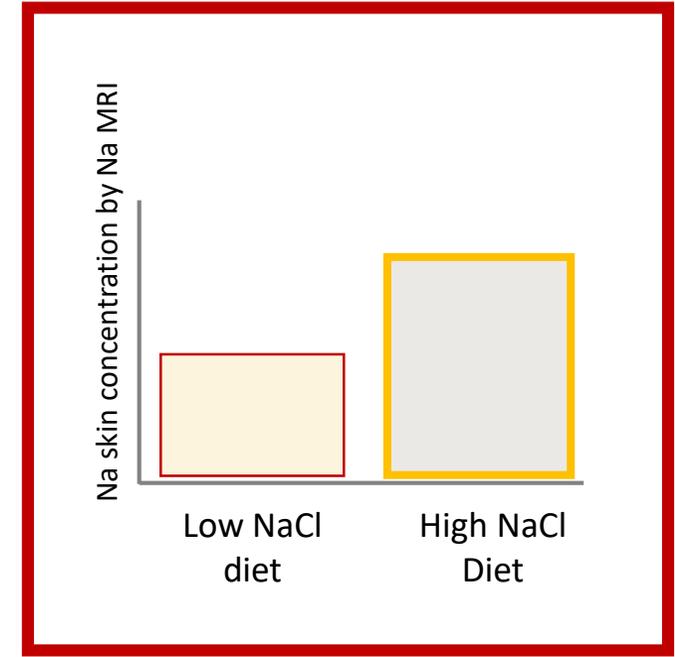


Maknick A, 2009, Nature Commun- Slagman M, NDT, 2012

# PHYSIOLOGIE DU SODIUM: EVOLUTION DU CONCEPT?



→ Non osmotically active Na



# LA SPECTRO-IRM: GÉNÉRALITÉS

13

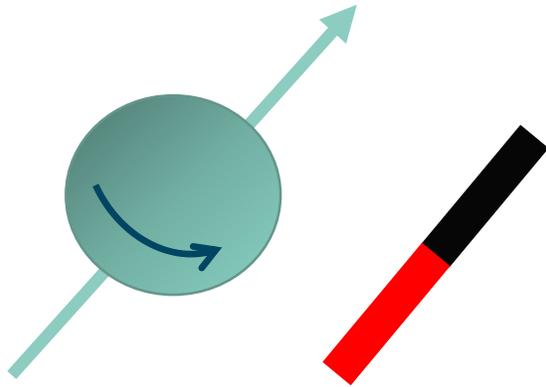
## RMN = RÉSONANCE MAGNÉTIQUE NUCLÉAIRE

- Le signal RMN provient du noyau de l'atome
- Tous les noyaux atomiques possèdent une charge en rotation, identifiée sous le nom de spin nucléaire
- Le plus connu: hydrogène H<sup>+</sup>
- Mais possible sur d'autres noyaux atomiques = <sup>31</sup>P, <sup>23</sup>Na, <sup>19</sup>F, <sup>13</sup>C

# LA SPECTRO-IRM: GÉNÉRALITÉS

## RMN = RÉSONANCE MAGNÉTIQUE NUCLÉAIRE

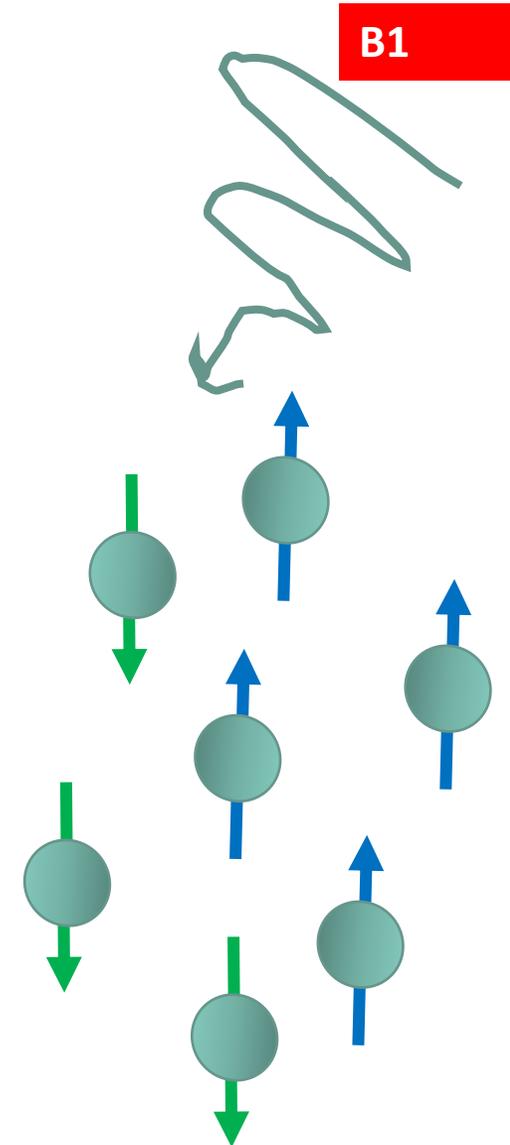
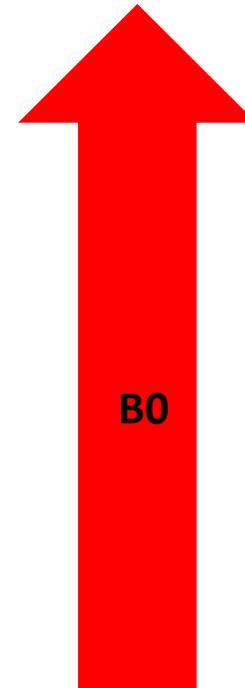
- Il faut un noyau qui possède un moment magnétique dit spin
- Il faut les orienter dans un grand champ magnétique pour les mesurer (=champ  $B_0$ )
- Signal très faible mais grand nombre de noyau



Mvt cinétique d'une particule chargée crée le champ magnétique

Mvt cinétique crée le moment magnétique

IRM 1,5 T – 3 T – 7T



# SPECTRO-RMN: IMPLICATIONS TECHNIQUES

De préférence sur des IRMs 3T

Contraintes techniques couteuses car:

La spectroscopie multinoyaux nécessite une **chaîne de radio-fréquence supplémentaire adaptée** en fréquence à chaque noyau étudié

**Antenne** de surface ou une birdcage

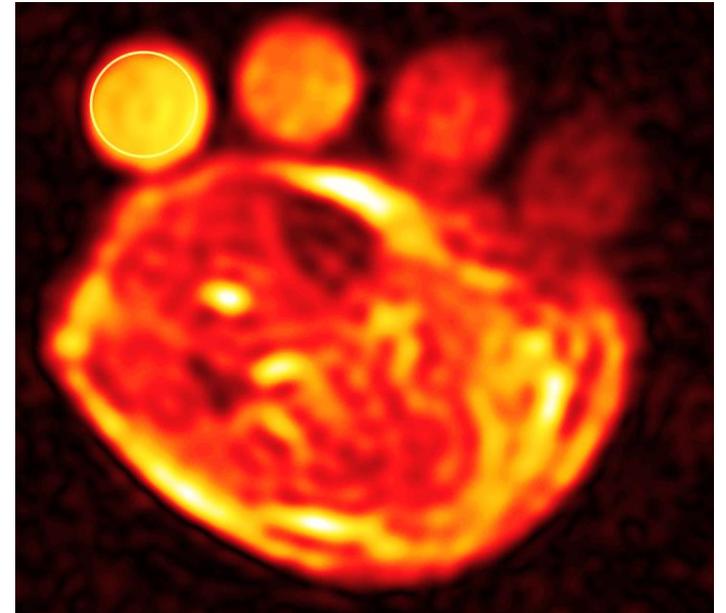
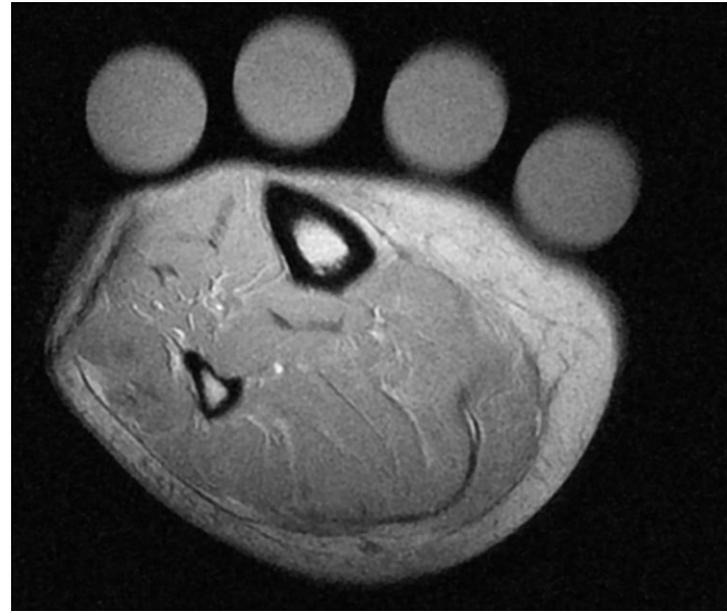


→ Nécessite un ingénieur/physicien



**Couplage images morphologiques (Proton) et fonctionnelle non invasive, quantitative ou semi-quantitative**

## $^{23}\text{Na}$ MRI : TECHNICALLY CHALLENGING



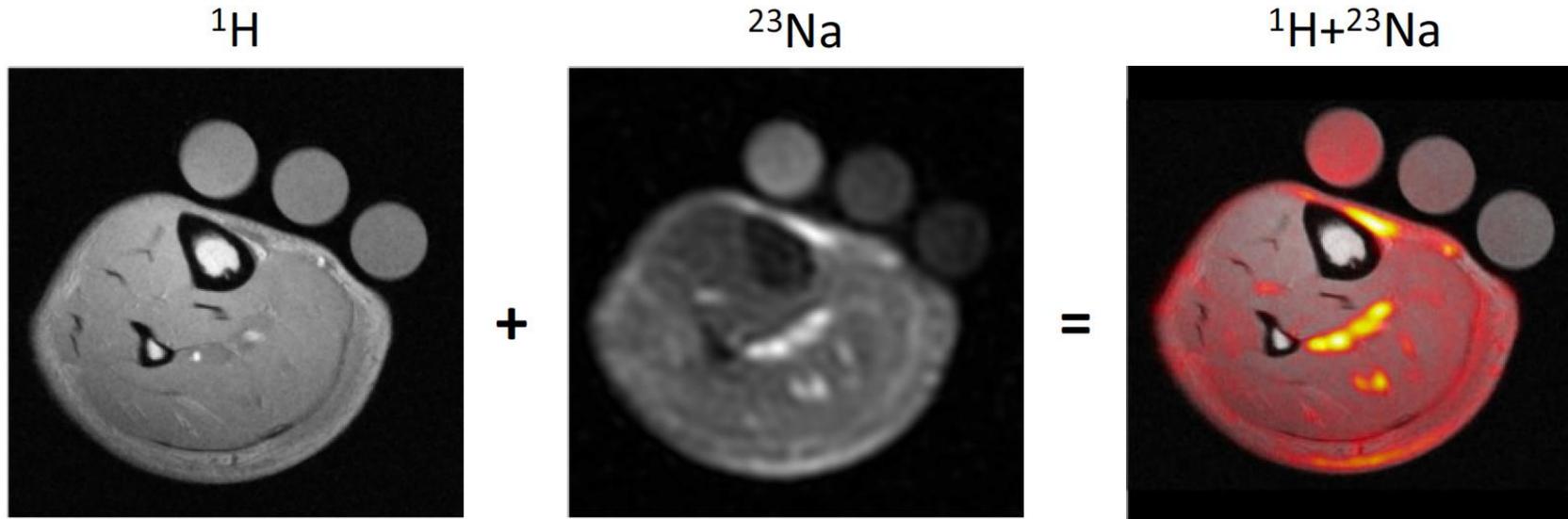
Mesure non invasive

Quantitative pour les organes superficiels

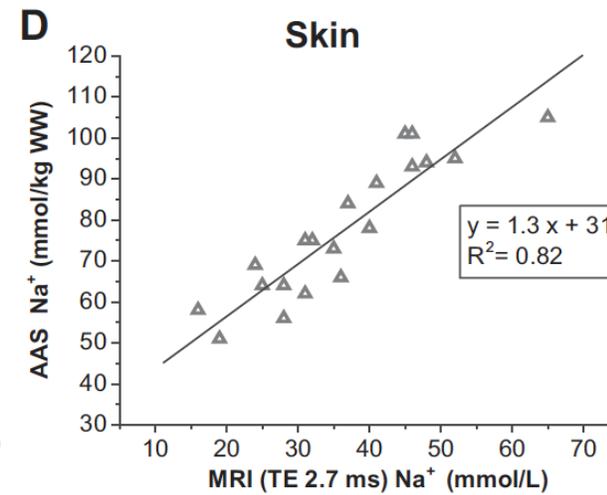
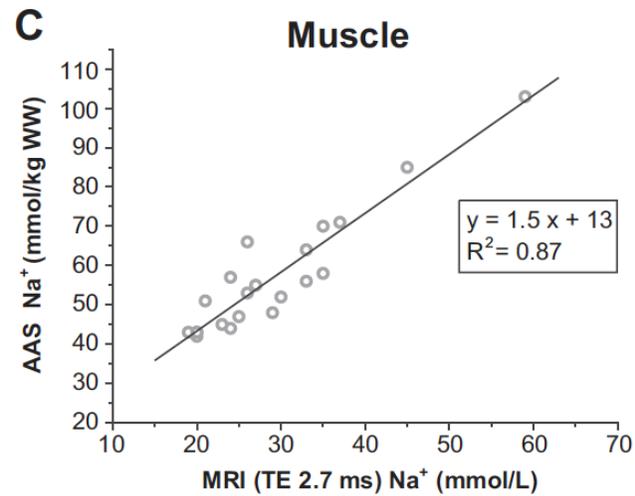
La sensibilité de l'IRM au sodium est d'env 10 % de celle du proton  $[\text{Na}^+] \lll [\text{H}^+]$

Temps de scannage pour 1 image = 15 min

# $^{23}\text{Na}$ MRI



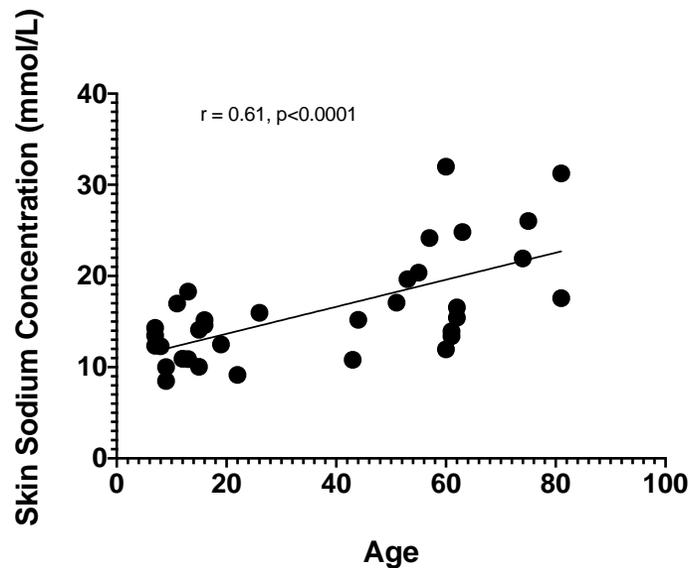
Membres amputés



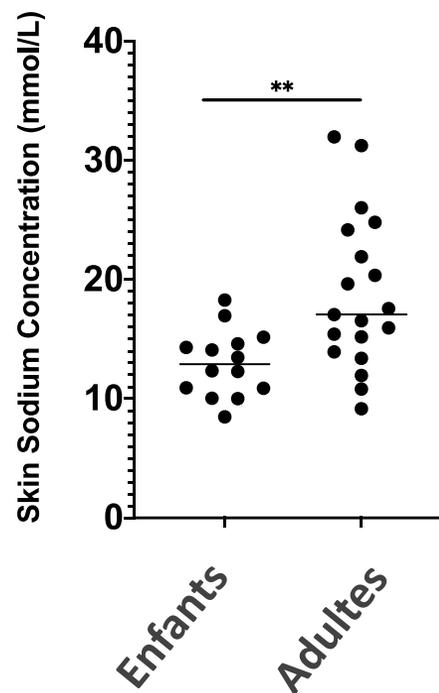
# BASICS IN SODIUM CONTENT

Unpublished data, S. Lemoine and C.M McIntyre.

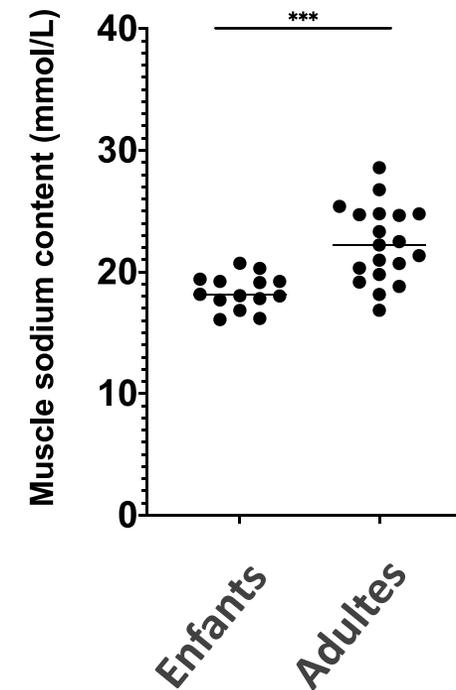
## Age



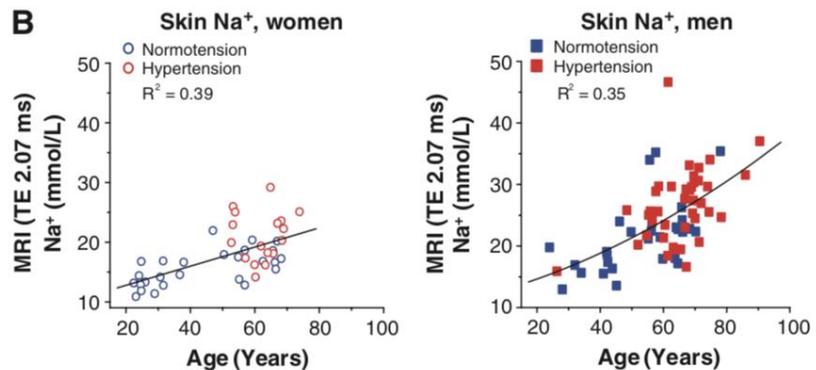
## Peau



## Muscle

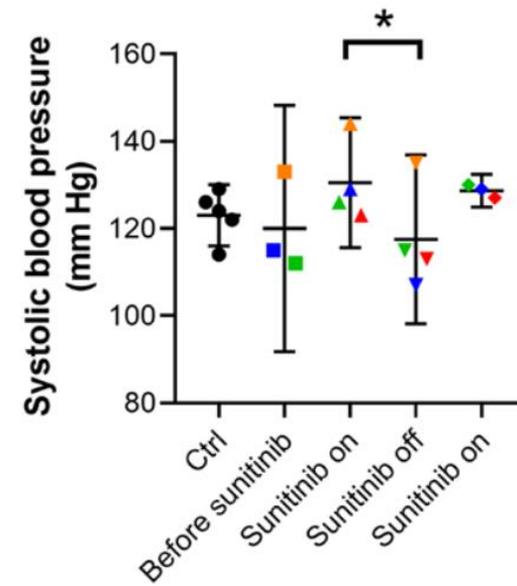
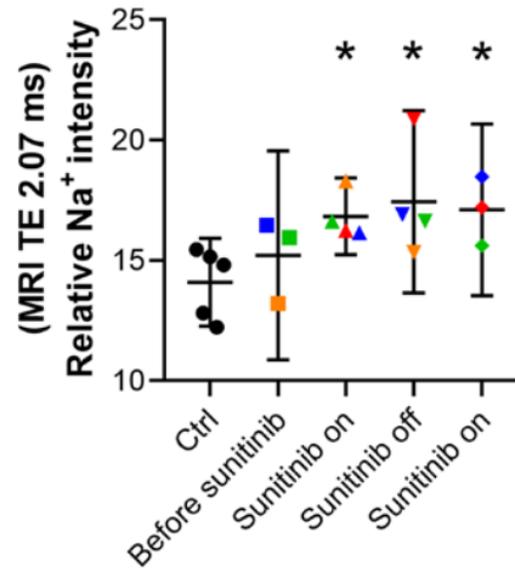
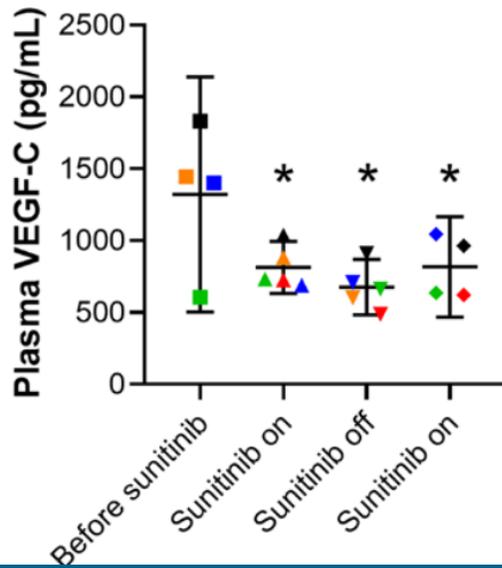
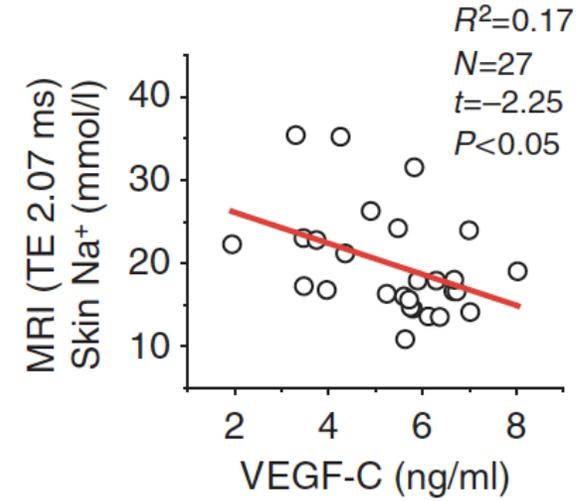
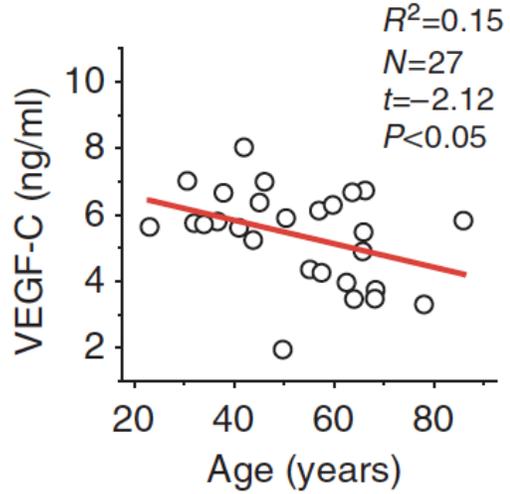
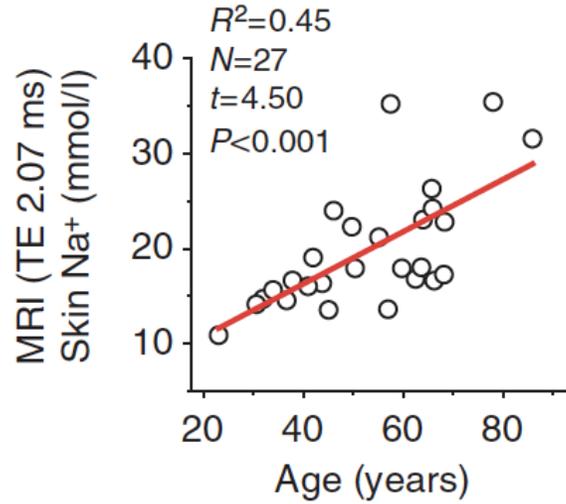


## Sexe

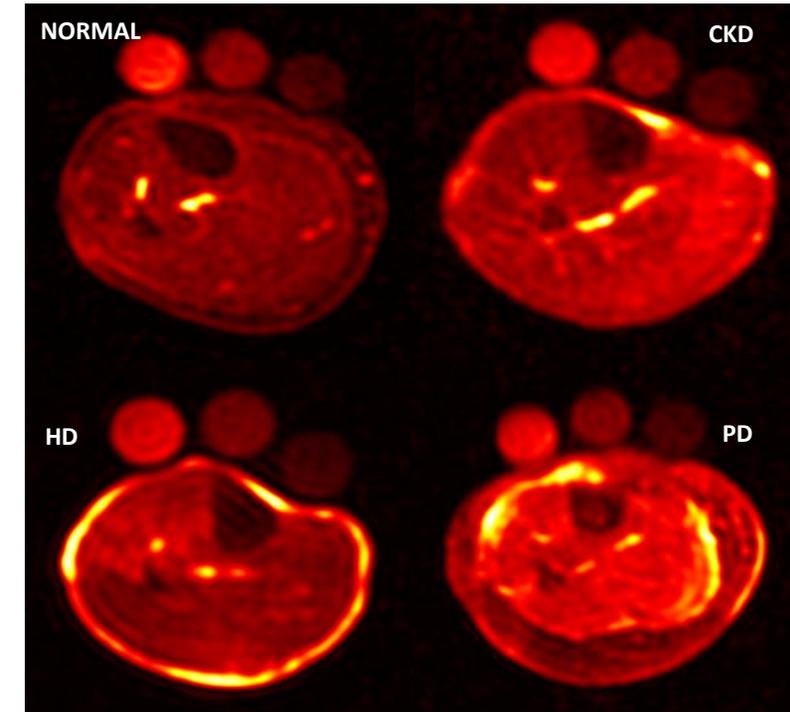
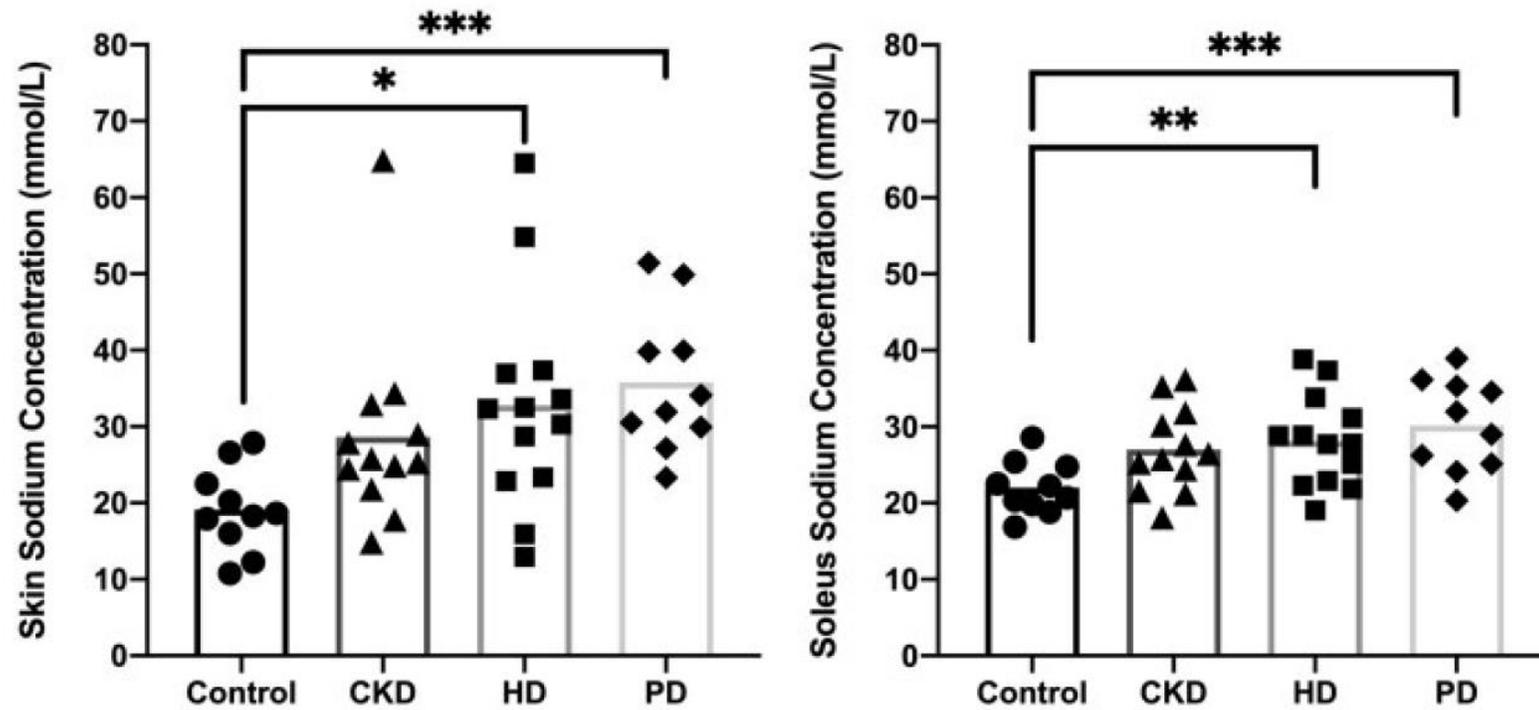


Kopp et al, hypertension, 2013

# NA PHYSIOLOGY: A NEW PARADIGM

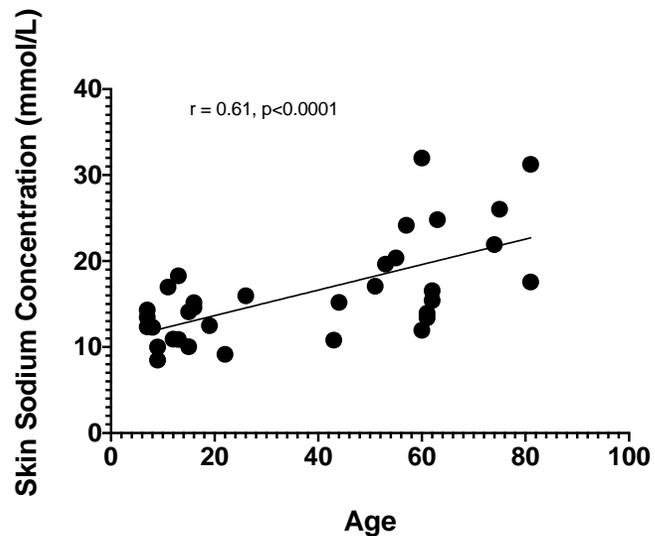


# SODIUM CONTENT, CKD AND DIALYSIS

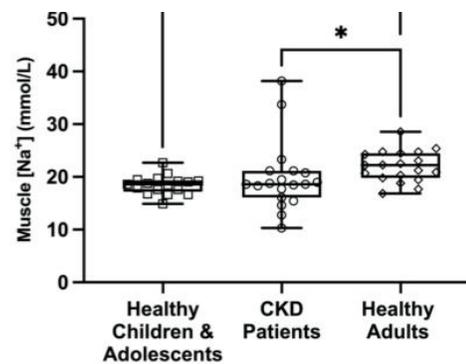
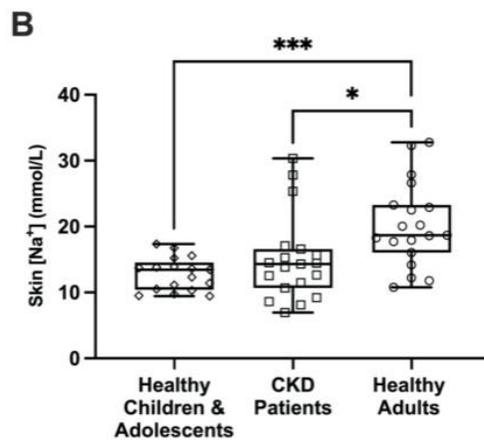
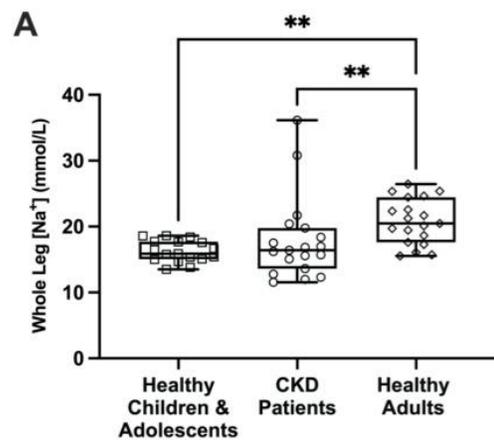
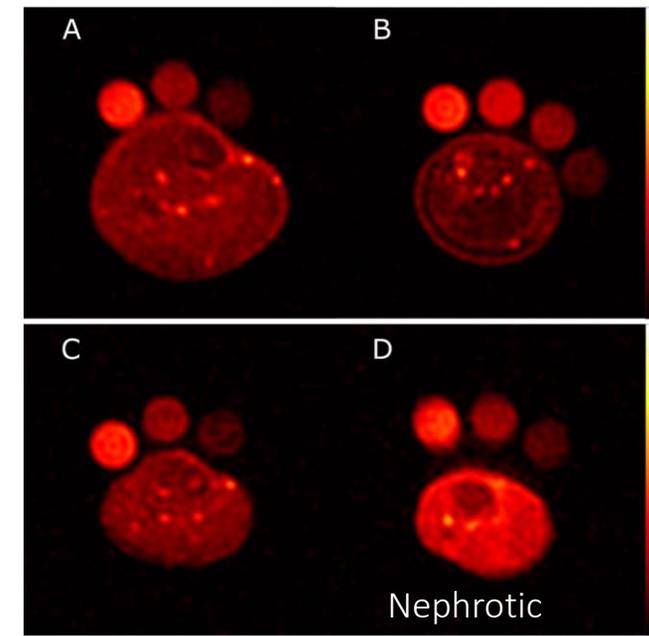
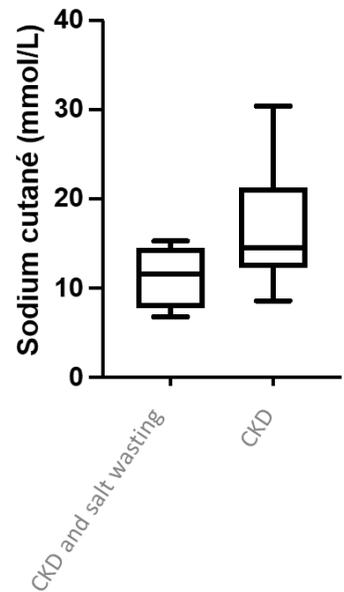


**FIGURE 4:** Between-group comparison in mean tissue sodium concentration [(A) skin; (B) soleus and (C) tibia]. \*P < 0.01; \*\*P < 0.001; \*\*\*P < 0.0001.

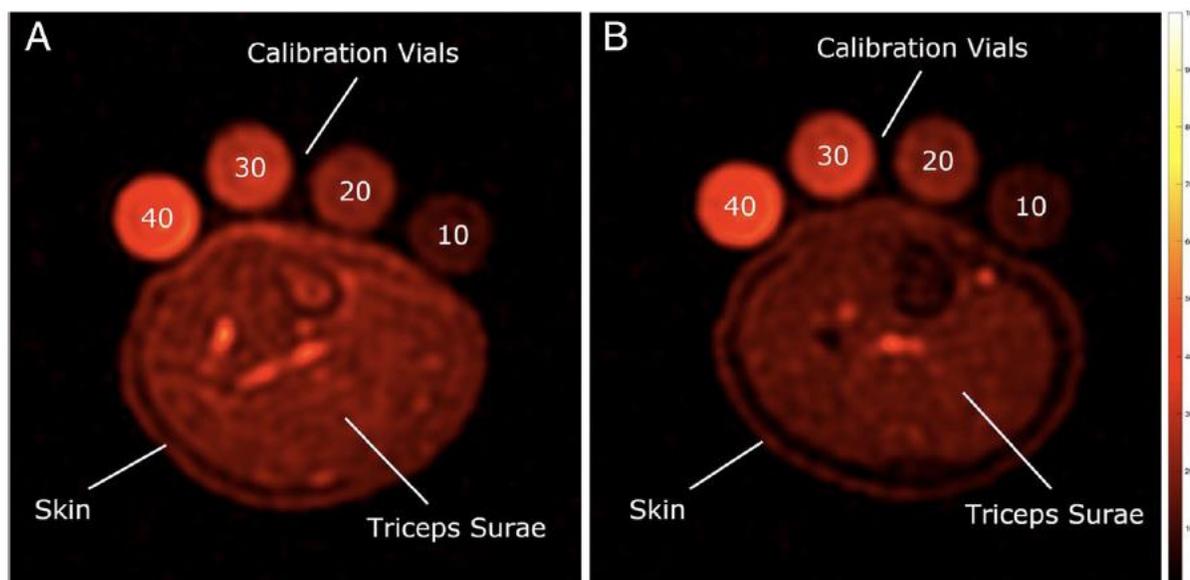
# SKIN CONTENT IN CHILDREN



Lemoine S, Mc Intyre, unpublished



# TUBULOPATHIE PROXIMALE ET STOCK DE SODIUM



Skin sodium = 10.681 mmol/L (z-score of -0.82 versus healthy children)

Muscle sodium : 14.608 mmol/L (z-score of -2.50 versus healthy children).

**Fig. 2** <sup>23</sup>Na MRI of the leg in a 13-year-old healthy female (**A**) and a 13-year-old female patient with Fanconi syndrome on indomethacin (**B**). Images show a substantially reduced skin [Na<sup>+</sup>] ((**A**) 15.2 mmol/L vs (**B**) 10.7 mmol/L) and triceps surae muscle [Na<sup>+</sup>] ((**A**) 18.6 mmol/L vs (**B**) 14.6 mmol/L) in our case in point, despite

decreased kidney sodium wasting. [Na<sup>+</sup>] measurement was possible by linear trend analysis as detailed in [11], using four calibration vials containing increasing concentrations of NaCl solution (from left to right: 40, 30, 20, 10 mmol/L). Tissue [Na<sup>+</sup>] is displayed as heat map, with greater signal intensity proportional to tissue [Na<sup>+</sup>]

# LE SODIUM TISSULAIRE A-T-IL UN IMPACT CLINIQUE ?

Relationship between skin sodium content and LVM (Schneider et al, JASN, 2017)

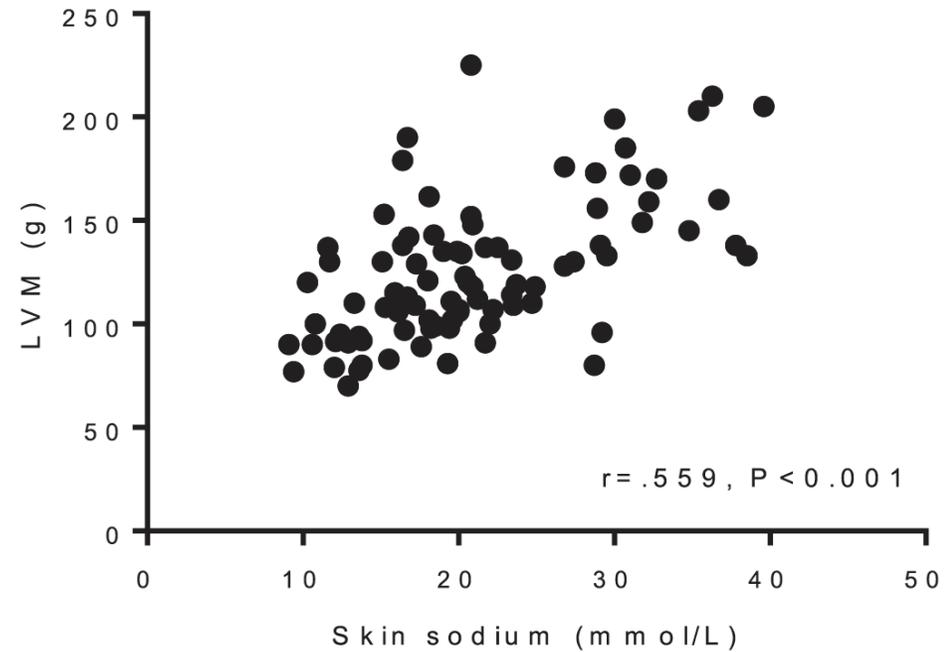


Figure 4. Relationship between skin sodium content and LVM.

# SODIUM TISSULAIRE ET RISQUE CV EN HD

## Methods

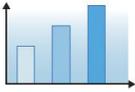
### Observational study



**Cohort:**  
Chronic HD/PD patients



**Imaging:**  
Skin [Na<sup>+</sup>] with <sup>23</sup>Na MRI (Leg)



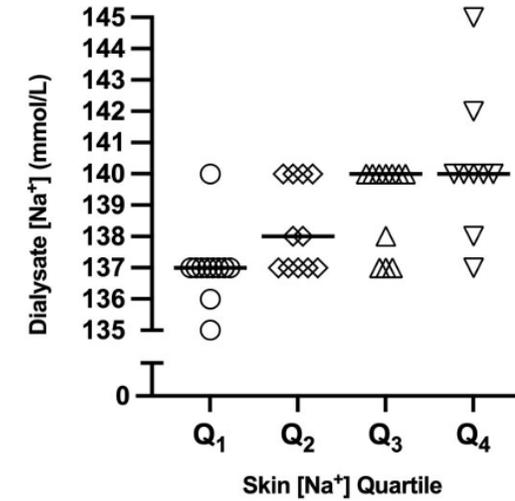
**Follow-up:**  
Clinical outcomes (death and MACE) by skin [Na<sup>+</sup>] quartile

## Results n=52 patients

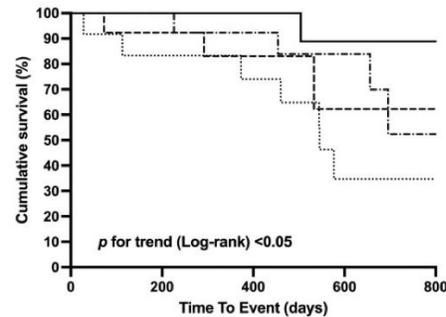
	Q <sub>1</sub> (n=11)	Q <sub>2</sub> (n=13)	Q <sub>3</sub> (n=15)	Q <sub>4</sub> (n=13)
Mean skin [Na <sup>+</sup> ] (mmol/L)	17.4	25.7	31.7	46.1
Median follow-up (days)	546	505	588	544
Deaths (n)	1	3	4	7
MACE (n)	1	1	2	3

### Cox regression for skin [Na<sup>+</sup>] (per 10 mmol/L)

<b>Death:</b> HR = 1.83 HR <sub>adjusted</sub> = 4.01	<b>Death and MACE:</b> HR = 1.72 HR <sub>adjusted</sub> = 2.32
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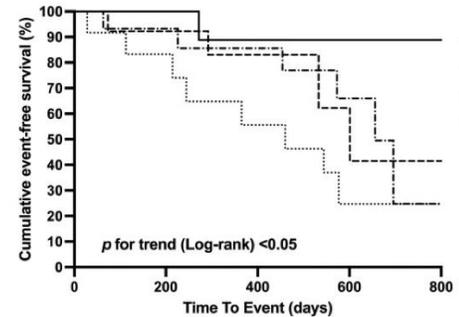


**A** Survival in 52 Dialysis Patients (42 HD, 10 PD) Stratified by Skin [Na<sup>+</sup>] Quartiles



No. at risk:	0	200	400	600	800
Q <sub>1</sub>	11	10	10	3	2
Q <sub>2</sub>	13	11	10	4	3
Q <sub>3</sub>	15	14	12	7	4
Q <sub>4</sub>	13	10	9	4	3

**B** Event-free Survival (All-cause Mortality + MACE) in 52 Dialysis patients (42 HD, 10 PD)

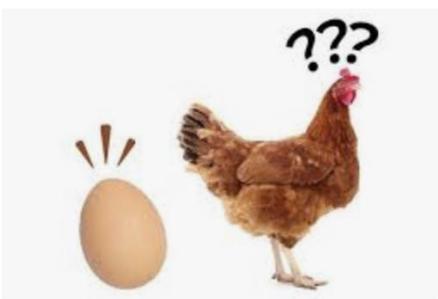
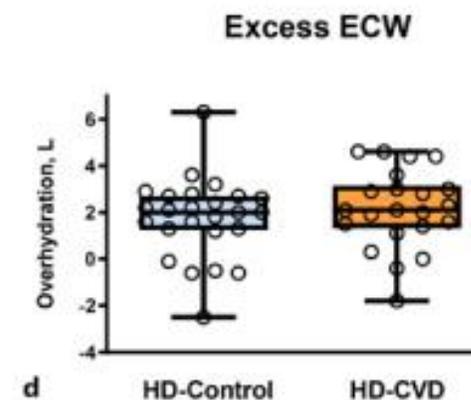
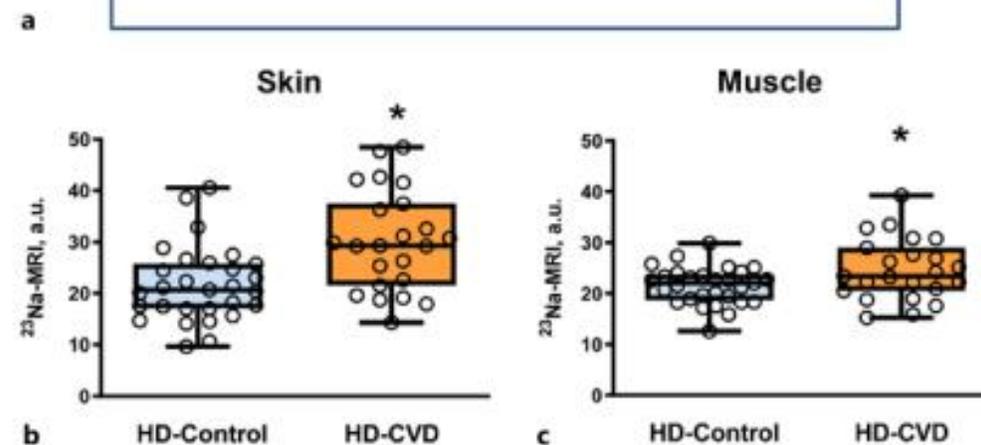
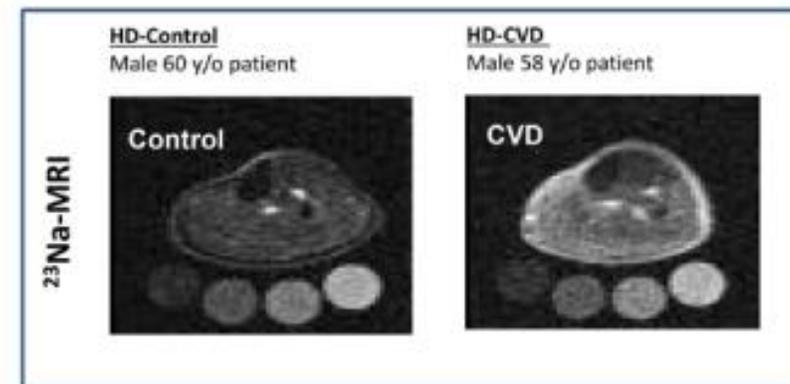


No. at risk:	0	200	400	600	800
Q <sub>1</sub>	11	10	9	3	2
Q <sub>2</sub>	13	11	10	4	3
Q <sub>3</sub>	15	13	11	5	2
Q <sub>4</sub>	13	10	7	3	3

FIGURE 2: Kaplan-Meier curves for overall survival (A) and event-free survival as a composite of all-cause mortality and MACE (B) after skin [Na<sup>+</sup>] quartile stratification.

# RESULTATS CONFIRMÉS PAR UNE AUTRE ÉQUIPE

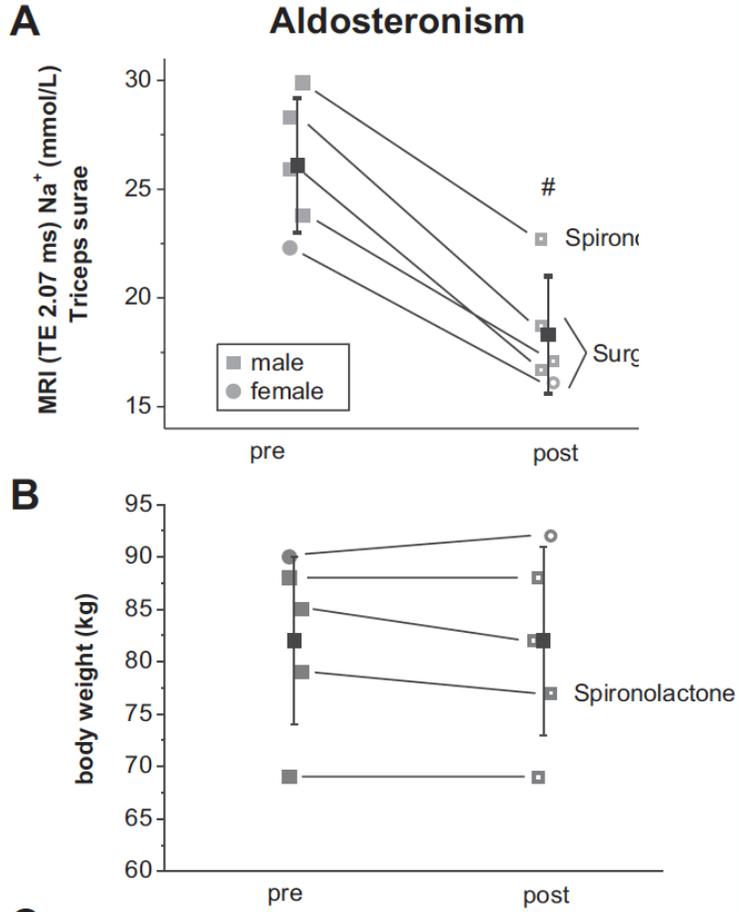
HD-related parameter			
HD vintage, years	1.6 (IQR 3.4)	2.5 (IQR 4.8)	0.22
HD technique	24 BHD/5 HDF	20 BHD/3 HDF	
Treatment time, h	4.5 (IQR 0.75)	4.75 (IQR 0.75)	0.39
Residual diuresis, mL/d	500 (IQR 950)	300 (IQR 500)	0.30
IDWG, kg	1.8±1.1	1.8±1.5	0.94
Ultrafiltration, L	2.2±1.1	2.3±1.2	0.71
Dialysate Na <sup>+</sup> , mmol/L	138 (IQR 3)	138 (IQR 0)	0.39
Dialysate bicarbonate, mmol/L	32 (IQR 3)	32 (IQR 3)	0.95
Laboratory data			
Plasma Na <sup>+</sup> , mmol/L	138±2	139±3	0.19
BIS data			
Total body water, L	38.2±5.9	40.6±7.7	0.25
ECW, L	18.7±3.2	20.0±3.4	0.18
ICW, L	19.5±3.2	20.6±4.6	0.37
Ratio ECW/ICW	0.96±0.12	0.99±0.11	0.43



**“Chicken or egg”?: Is tissue Na<sup>+</sup> overload involved in the development of CVD or does CVD itself lead to tissue Na<sup>+</sup> retention?**

# CAN SODIUM BE MOBILIZED?

## In hyperaldosteronism



Kopp et al, hypertension, 2012

## With loop diuretic

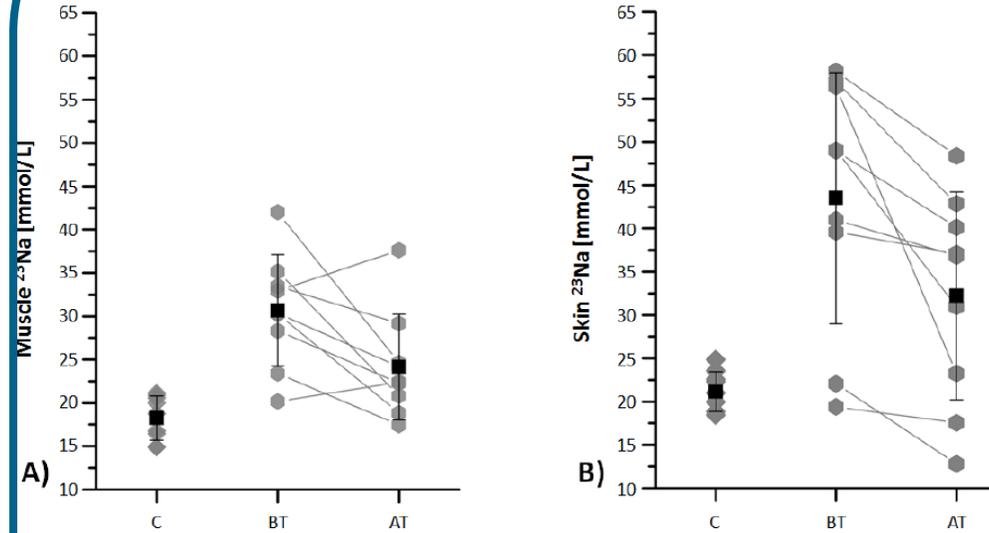
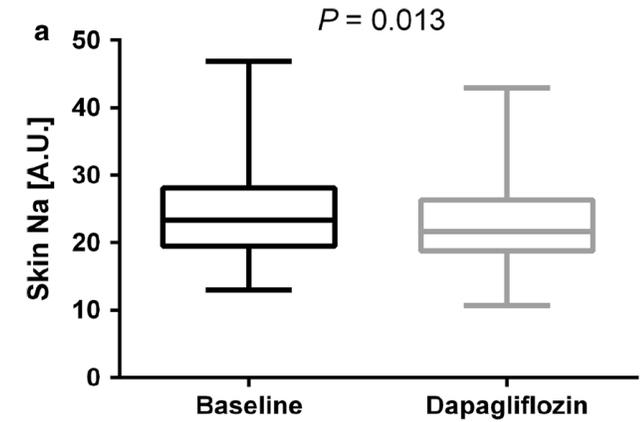


Table 2. Demographic data and results.

	Patients	
<b>Gender</b>	7 men/2 women	
<b>Age [years]</b>	78 (range: 58–87)	
	Before Therapy	After Therapy
<b>Muscle Na<sup>+</sup> [mmol/L]</b>	30.7 ± 6.4	24.2 ± 6.1
<b>Skin Na<sup>+</sup> [mmol/L]</b>	43.5 ± 14.5	32.2 ± 12.0
<b>Whole lower leg Na<sup>+</sup> [mmol/L]</b>	44.7 ± 15.3	29.9 ± 10.7

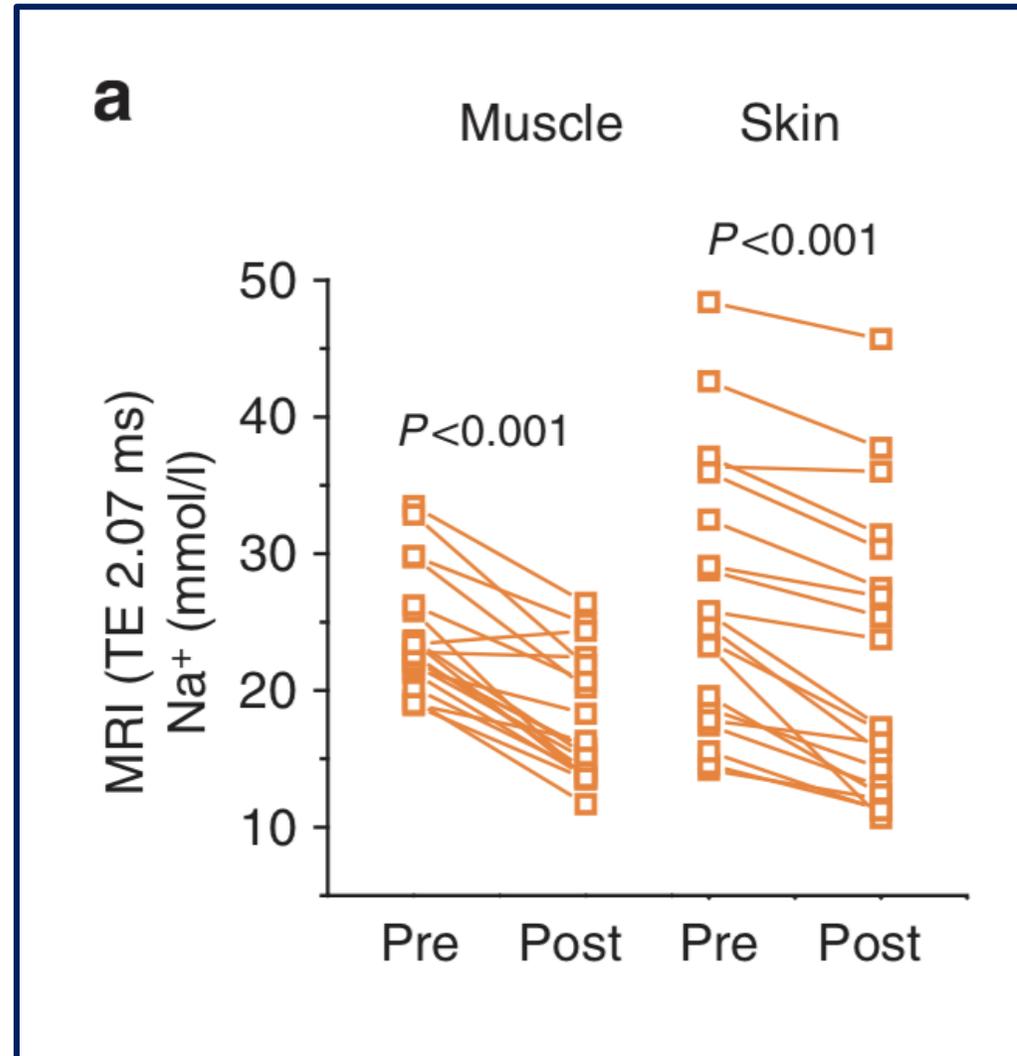
Hammon et al, Plos one, 2025

## With SGLT2i



Karg et al. Cardiovasc Diabetol (2018)

# LE SODIUM TISSULAIRE PEUT-IL ÊTRE MOBILISÉ EN DIALYSE ?



**HD removes osmotic and non osmotic active sodium**

**Table 1** Recent studies investigating the effect of low dialysate sodium in patients on hemodialysis

Author (year)	No. of studies, no. of patients	Design	Main findings
<b>Meta-analysis</b>			
Dunlop et al., 2019 [30]	12 RCTs, 310 patients	Cochrane meta-analysis of RCTs comparing low (<138 mmol/L) versus neutral (138 to 140 mmol/L) or high (>140 mmol/L) dNa <sup>+</sup> for maintenance HD patients	<p>Compared to neutral or high dNa<sup>+</sup>, low dNa<sup>+</sup> had the following effects:</p> <ul style="list-style-type: none"> <li>➤ Reduced IDWG: 10 studies, MD -0.35 kg (95% CI -0.18 to -0.51)</li> <li>➤ Probably reduced predialysis mean BP: 4 studies, MD -3.58 mmHg (95% CI -5.46 to -1.69)</li> <li>➤ Probably reduced postdialysis mean BP: 4 studies, MD -3.26 mmHg (95% CI -1.70 to -4.82)</li> <li>➤ probably reduced predialysis serum Na<sup>+</sup>: 7 studies, MD -1.69 mmol/L (95% CI -2.36 to -1.02)</li> <li>➤ probably increased intradialytic hypotension events: 9 studies, OR 1.56 (95% 1.17 to 2.07)</li> <li>➤ probably increased intradialytic cramps: 6 studies, OR 1.77 (95% 1.15 to 2.73)</li> </ul>
<b>Adult RCTs published after the meta-analysis</b>			
Marshall et al., 2020 [31]	99 patients with a predialysis serum Na <sup>+</sup> > 135 mmol/L, receiving HD at home or a self-care satellite facility	Parallel arm RCT: dNa <sup>+</sup> 135 vs. 140 mmol/L for 12 months	<ul style="list-style-type: none"> <li>➤ No change in left ventricular mass index: -3.94 g/m<sup>2</sup> at 12 months (95% CI 210.52 to 2.63)</li> <li>➤ Significant reductions at 6 and 12 months in IDWG, in extracellular fluid volume, and in plasma B-type natriuretic peptide concentration</li> <li>➤ Increased intradialytic hypotension (OR 7.5; 95% CI 1.1 to 49.8 at 6 months and OR 3.6; 95% CI 0.5 to 28.8 at 12 months)</li> </ul>
Causland et al., 2022 [35]	139 hospitalized patients on maintenance HD	Parallel arm RCT: dNa <sup>+</sup> 138 vs. 142 mmol/L for up to 6 sessions	<ul style="list-style-type: none"> <li>➤ No significant differences in the average systolic BP decline: 23±16 versus 26±16 mmHg; <i>p</i>=0.57</li> <li>➤ Similar proportion of total sessions complicated by hypotension: 54% versus 59%; OR 0.72 (95% CI 0.36-1.44; <i>p</i>=0.35)</li> <li>➤ In post hoc analyses adjusting for imbalances in baseline characteristics, higher dNa<sup>+</sup> associated with 8 mmHg (95% CI 2-13 mmHg) less decline in systolic BP, compared with lower dNa<sup>+</sup></li> </ul>
<b>Pediatric studies</b>			
Marsenic et al., 2016 [33]	5 patients aged 4-17 years	Retrospective study. Follow-up 6-11 months per patient. dNa <sup>+</sup> 140 mmol/L during the first half, and 138 mmol/L during the second half of the study period for each patient	<p>Lowering dNa<sup>+</sup> associated with the following:</p> <ul style="list-style-type: none"> <li>➤ Reduced pre-HD systolic BP: 127 (117-140) vs. 133 (122-143) mmHg (<i>p</i>&lt;0.01)</li> <li>➤ Reduced pre-HD diastolic BP: 73 (68-84) vs. 84 (75-90) mmHg (<i>p</i>&lt;0.01)</li> <li>➤ Reduced IDWG: 2.21% (1.03-3.64) vs. 2.86% (1.16-4.5) (<i>p</i>&lt;0.01)</li> </ul>

# Prospective Study of Modifiable Risk Factors of Arterial Hypertension and Left Ventricular Hypertrophy in Pediatric Hemodialysis Patients

## Cohort

### International Pediatric Hemodialysis Network



65 Dialysis Centers

Dec 2012 – Dec 2021



Clinical Data  
Collected at Baseline  
and Every 6 Months



Patients Ages 0-21



Receiving 2-6 HD/F  
sessions per week

**N = 910**

## Results



Uncontrolled hypertension present in 55%

BP-SDS independently associated with:  
number of antihypertensive meds

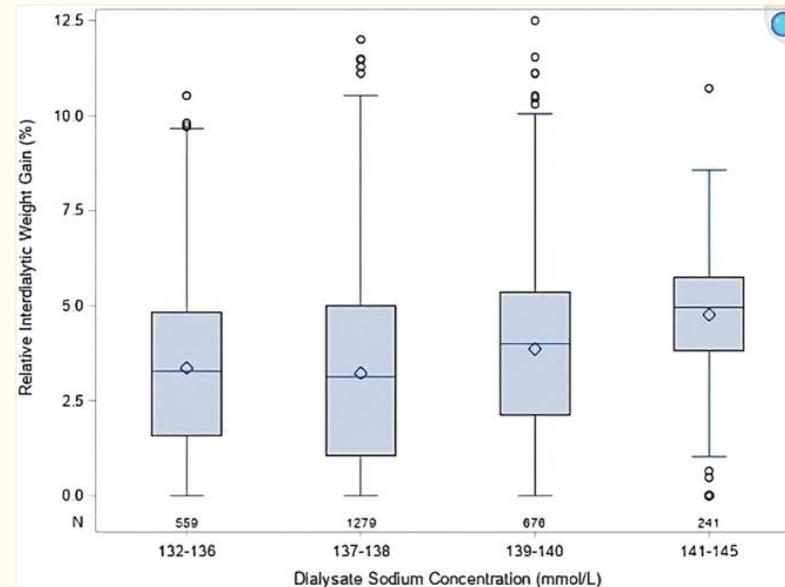
Systolic OR 1.47 [1.39-1.56],  $p < 0.0001$

Diastolic OR 1.36 [1.23-1.36],  $p < 0.0001$

and IDWG

Systolic OR 1.19 [1.14-1.22],  $p < 0.0001$

Diastolic OR 1.09 [1.06-1.11],  $p < 0.001$



No association between dNa and incidence of intradialytic hypotension

### Pediatric studies

Marsenic et al., 2016 [33] 5 patients aged 4–17 years

Retrospective study. Follow-up 6–11 months per patient.  $dNa^+$  140 mmol/L during the first half, and 138 mmol/L during the second half of the study period for each patient

Lowering  $dNa^+$  associated with the following:

- Reduced pre-HD systolic BP: 127 (117–140) vs. 133 (122–143) mmHg ( $p < 0.01$ )
- Reduced pre-HD diastolic BP: 73 (68–84) vs. 84 (75–90) mmHg ( $p < 0.01$ )
- Reduced IDWG: 2.21% (1.03–3.64) vs. 2.86% (1.16–4.5) ( $p < 0.01$ )

Author (year)	No. of studies, no. of patients	Design	Main findings
Caporale et al., 2022 [34]	25 patients < 25 years	Crossover RCT: $dNa^+$ 135 vs. 138 mmol/L for 4 weeks	<ul style="list-style-type: none"> <li>➤ Pre-HD systolic and diastolic BP not different between the two treatments</li> <li>➤ Mean IDWG significantly lower with low <math>dNa^+</math> than with standard <math>dNa^+</math>: <math>2.12 \pm 1.39\%</math> vs. <math>2.77 \pm 1.53\%</math>, (<math>p = 0.008</math>)</li> <li>➤ More negative mean <math>Na^+</math> gradient (<math>dNa^+</math>–serum <math>Na^+</math>) with low <math>dNa^+</math>: <math>-2.53 \pm 2.4</math> mmol/L vs. <math>0.17 \pm 2.8</math> mmol/L (<math>p = 0.0001</math>)</li> <li>➤ Similar incidence of symptomatic sessions (1.0% vs. 1.0%)</li> </ul>

# METHOD

## ✓ hypothesis

Na dialysate prescription can modify tissular sodium content

Prospective observational study  
*NCT03004547*



36 patients in HD > 3 mois

**resolve**

Randomised Evaluation of Sodium dialysate Levels on Vascular Events

18 patients [137 mmol/L]

18 patients [140 mmol/L]

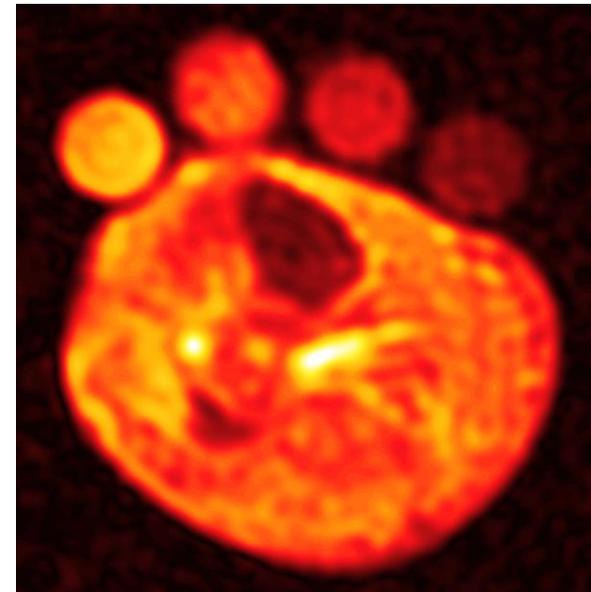
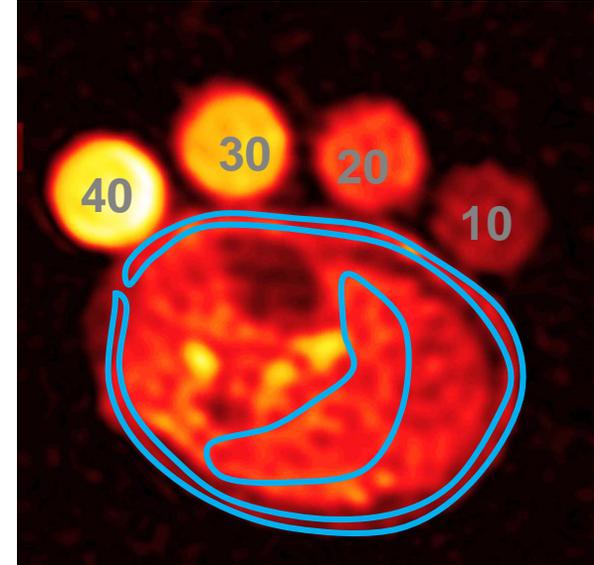


<sup>23</sup>NaMRI

Mid week  
Non dialysis day



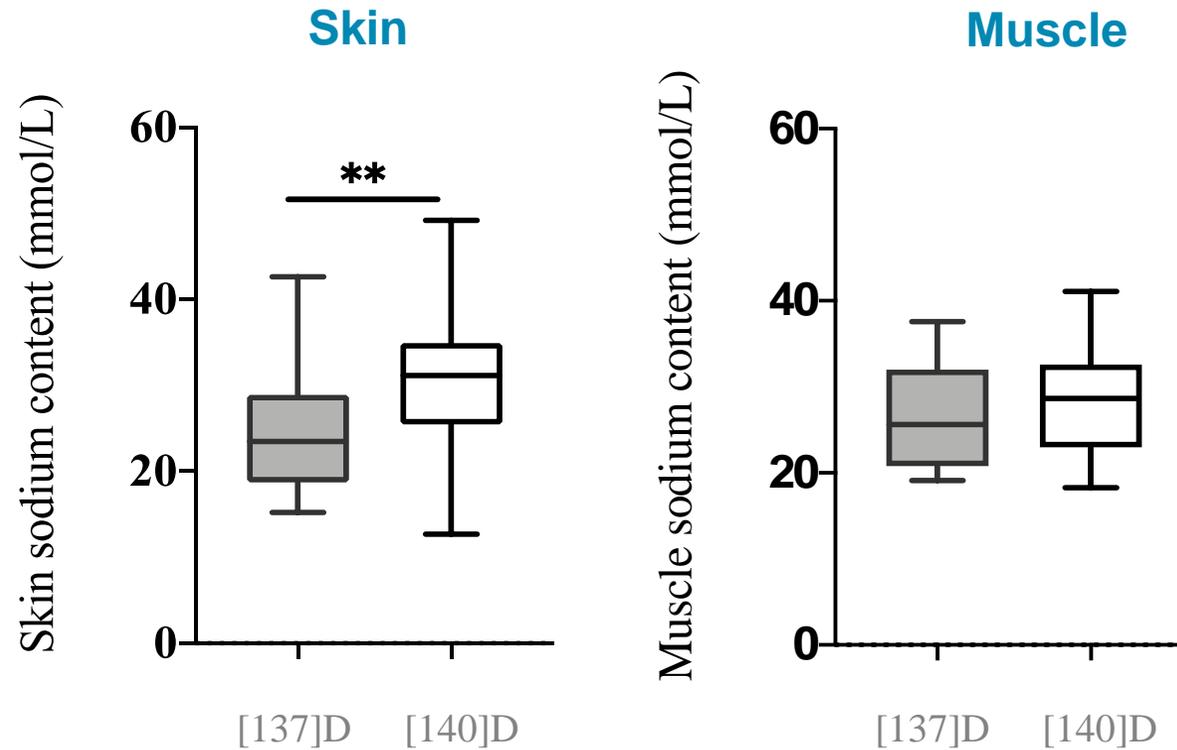
Blood pressure



# PATIENTS CHARACTERISTICS

	137 mmol/L	140 mmol/L
Age	66 yo (47-79)	65 yo (40-82)
% men	55%	66%
BMI (kg/m <sup>2</sup> )	31,5 (21.6 – 41.1)	32.4 (21.4 – 43)
PAS/PAD	128/73 mmHg	133/79 mmHG
% Hypertension	83 %	88 %
% DT2	57 %	66 %
Dialysis vintage	19 months	22 months
Interdialytic weight	1.65 kg (0 – 3.2)	2.3 kg (0.1 – 5)

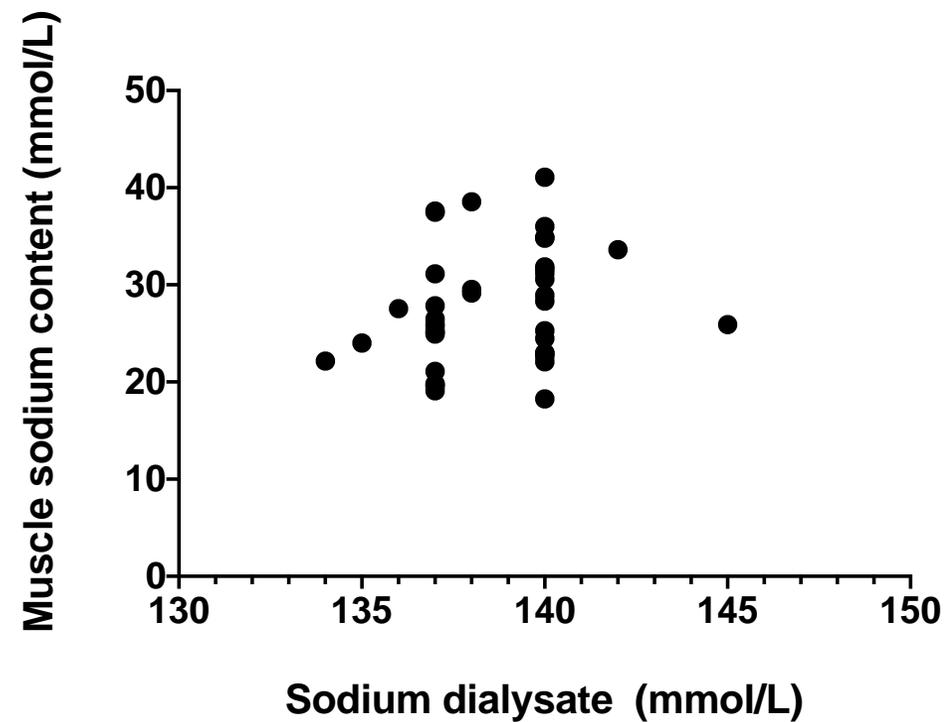
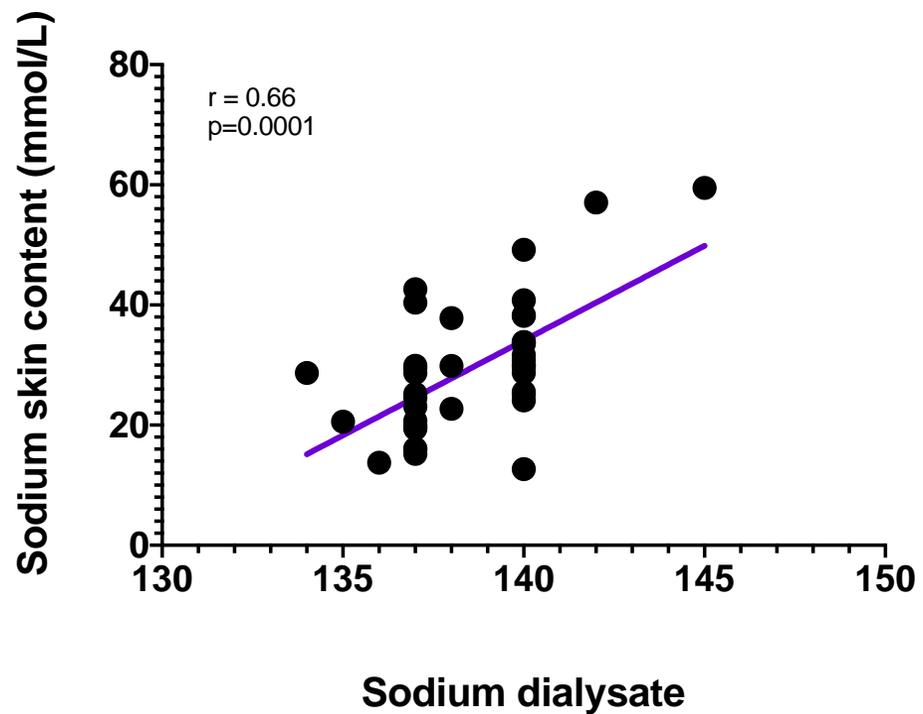
# SODIUM 137 ET 140 MMOL/L PRESCRIPTION AND TISSULAR SODIUM CONTENT



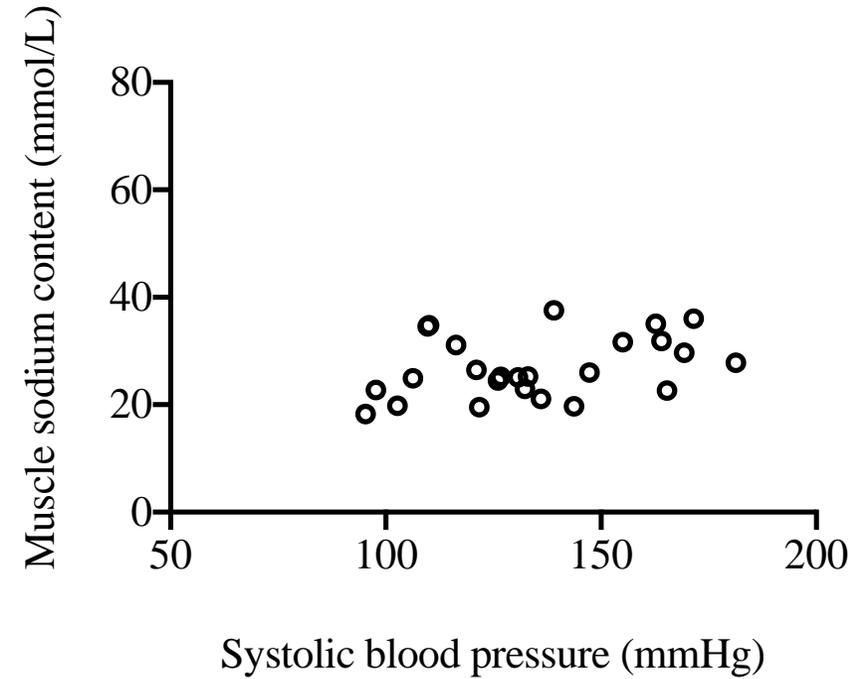
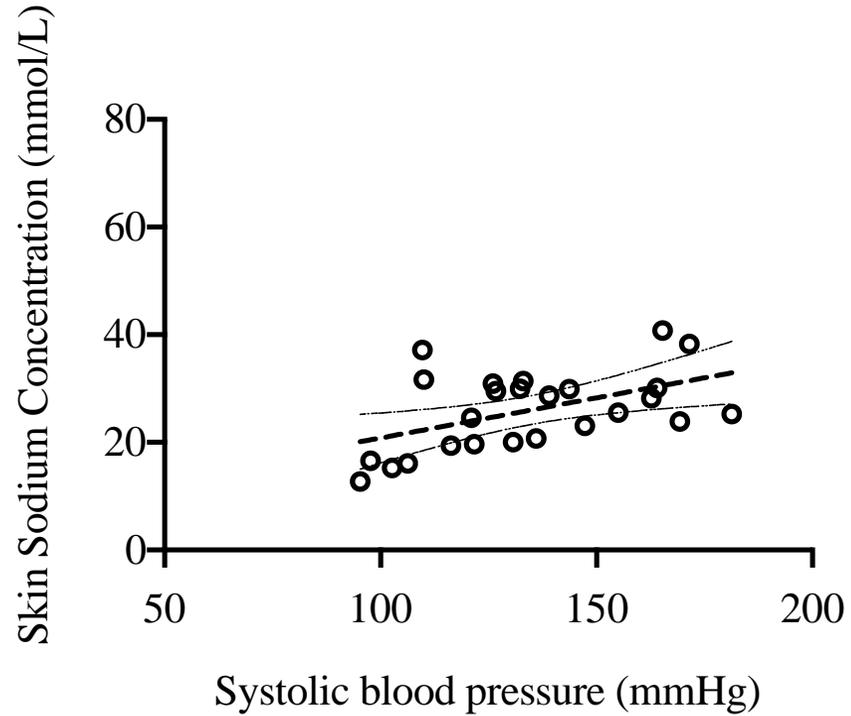
→ skin sodium content is significantly lower in [137] than [140] concentration

# RELATIONSHIP BETWEEN SODIUM DIALYSATE AND TISSULAR SODIUM

On the whole Cohorts, n=40



# BLOOD PRESSURE AND SODIUM CONTENT



→ Positive correlation between BP and skin sodium concentration

# DO WE HAVE OTHERS PARAMETERS IN HD THAT COULD IMPACT TISSULAR SODIUM CONTENT ?

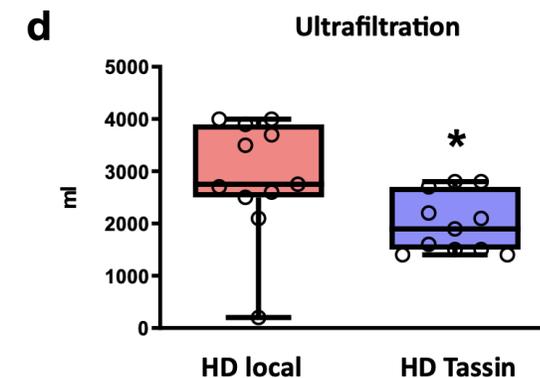
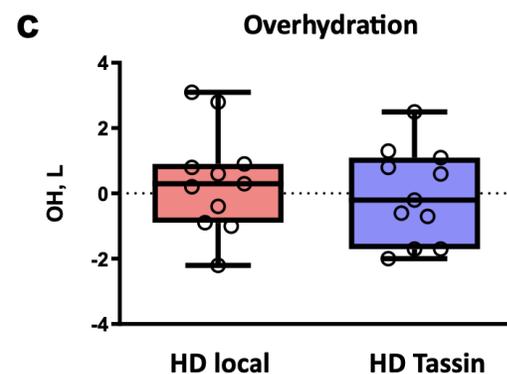
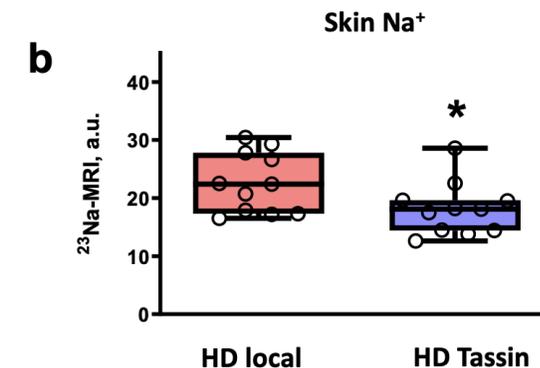
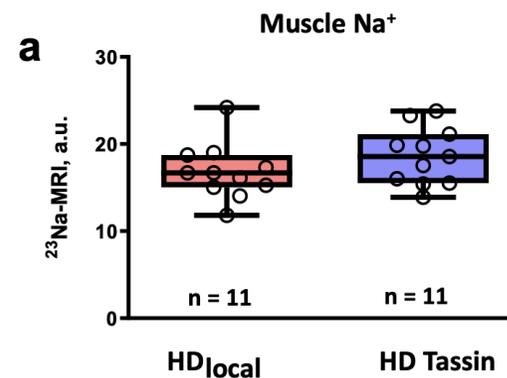
→ No impact of residual kidney function, dialysis vintage and vascular access.

# QUELS IMPACTS SUR LE SODIUM TISSULAIRE DES PARAMÈTRES D'HD?

1) Durée longue d'HD associée à un régime strict en sodium (Tassin, France)

11 patients de Tassin vs 11 patients matchées en âge et sexe d'Allemagne

**La concentration cutanée de sodium est-elle du UF?**  
**Sodium du dialysat?**  
**Longueur du traitement?**



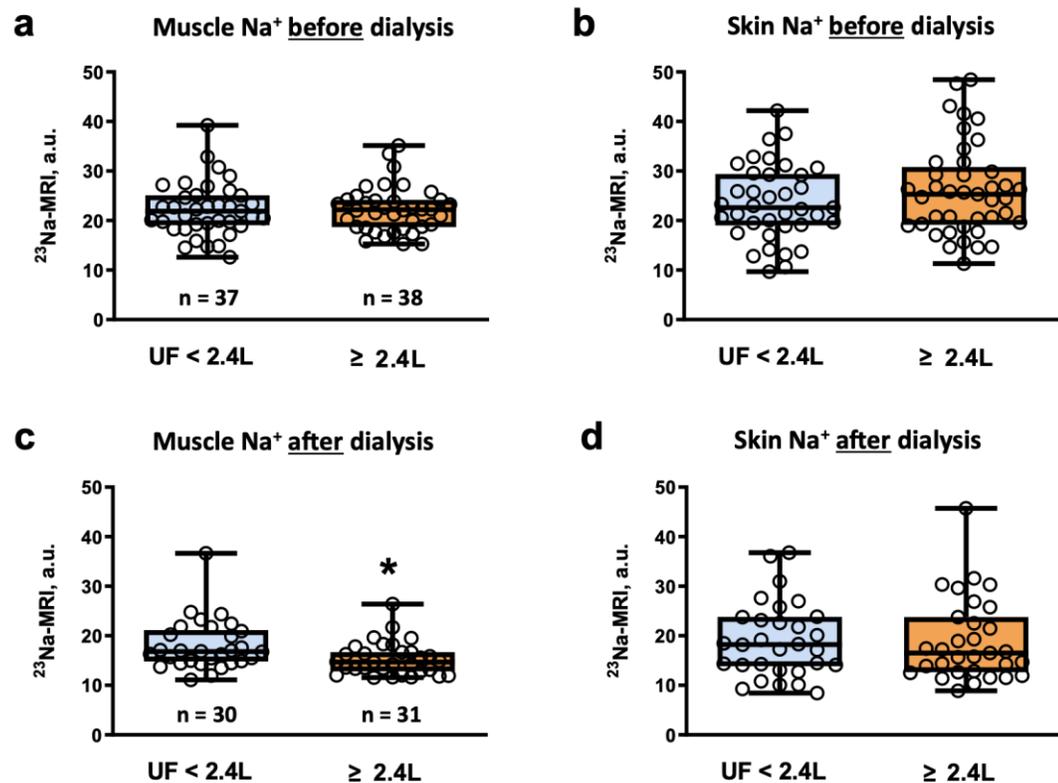
# QUELS IMPACTS SUR LE SODIUM TISSULAIRE DES PARAMÈTRES D'HD?

2) Cohorte d'HD en Allemagne (n=75 patients)

- Part A: UF : 37 patients en HD UF <2.4 l vs 38 patients on HD > 2.4 l
- Part B: 41 patients HD < 4.5 hrs vs 34 patients HD >4.5 hours.
- Part C: 17 patients HD [Na]dialysat = 138 mmol/l vs 58 patients [Na]dialysat < 138 mmol/l.

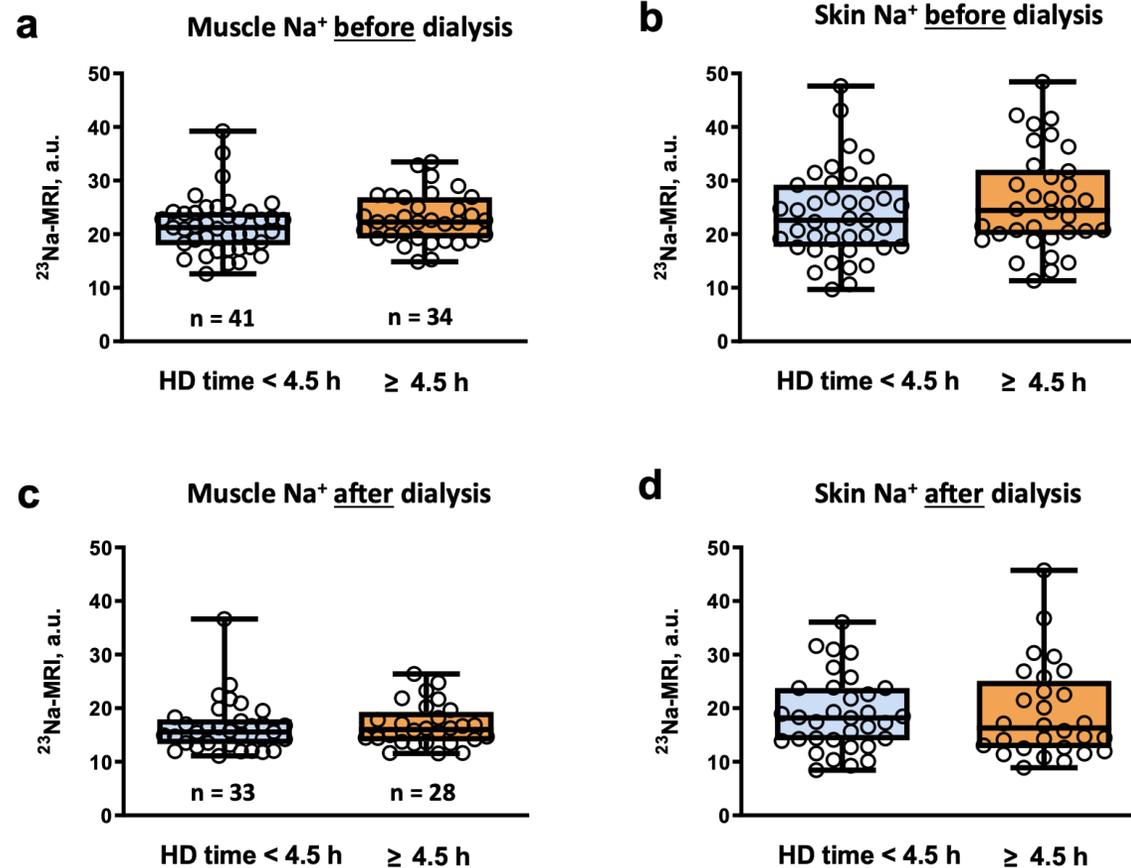
# QUELS IMPACTS SUR LE SODIUM TISSULAIRE DES PARAMÈTRES D'HD?

→ Part A: UF : 37 patients en HD UF <2.4 l vs 38 patients on HD > 2.4 l



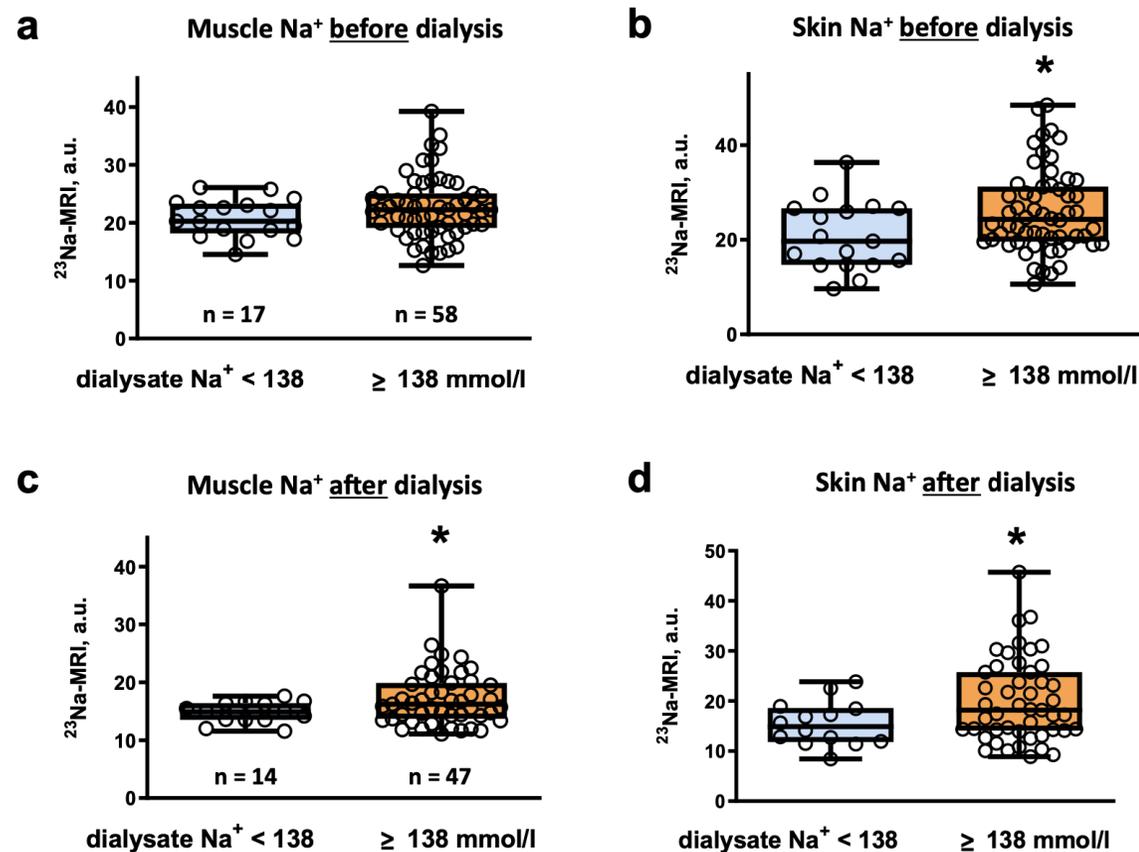
# QUELS IMPACTS SUR LE SODIUM TISSULAIRE DES PARAMÈTRES D'HD?

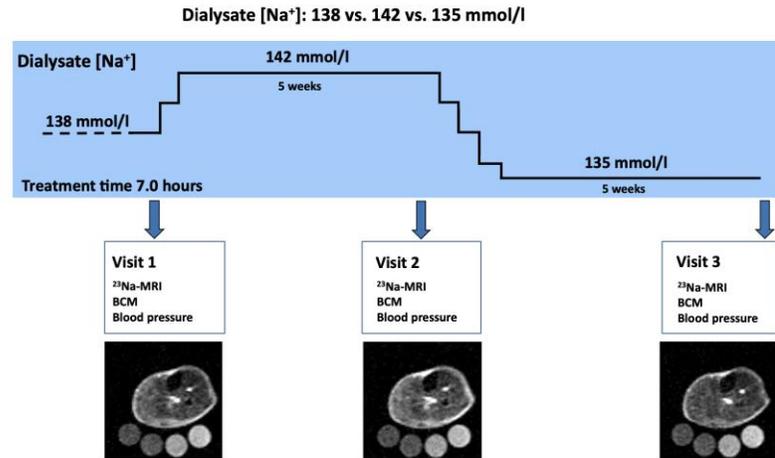
Part B: 41 patients HD < 4.5 hrs vs 34 patients HD >4.5 hours.



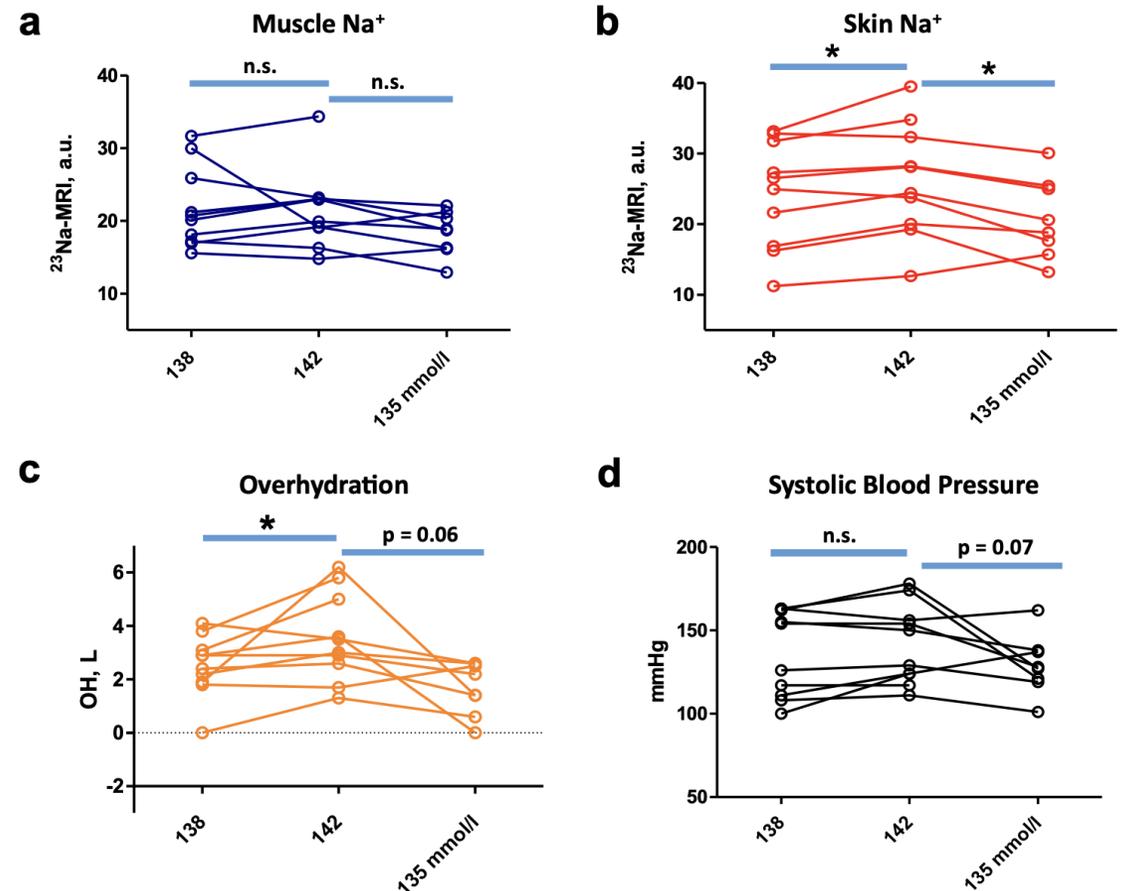
# QUELS IMPACTS SUR LE SODIUM TISSULAIRE DES PARAMÈTRES D'HD?

Part C: 17 patients HD [Na]dialysat = 138 mmol/l vs 58 patients [Na]dialysat < 138 mmol/l.





**Figure 6.** Study synopsis of interventional cross-over adaptation of dialysate [Na<sup>+</sup>]. Upper panel: timeline of stepwise changes in dialysate [Na<sup>+</sup>] from 138 to 142 to 135 mmol/l with according visits 1 to 3. Lower panel: Representative <sup>23</sup>Na-MR images of the left calf during visits 1 to 3. Calibration tubes with 10, 20, 30, and 40 mmol/l NaCl are situated below the leg; the brightness of the resonance signal reflects the Na<sup>+</sup> amount. <sup>23</sup>Na-MRI, <sup>23</sup>Na magnetic resonance imaging; a.u., arbitrary unit; BCM, body composition monitor.



Characteristics	Dialysate Na <sup>+</sup> 138 mmol/l n = 10	Dialysate Na <sup>+</sup> 142 mmol/l n = 10	Dialysate Na <sup>+</sup> 135 mmol/l n = 8	P value 138 vs. 142/ 142 vs. 135
<b>Demographics</b>				
Age, yr	50.5 ± 13.2	-	-	-
Body weight, kg	89.8 ± 14.5	89.9 ± 15.3	89.8 ± 14.6	0.80/0.74
<b>HD-related parameter</b>				
HD vintage, yr	5.6 (IQR 7.1)	-	-	-
Treatment time, h	7.0 (IQR 1.6)	7.4 (IQR 1.7)	7.4 (IQR 2.3)	0.34/0.67
Ultrafiltration volume, l	2.1 ± 1.6	1.9 ± 1.3	1.7 ± 0.9	0.62/0.83
<b>Laboratory data</b>				
Serum Na <sup>+</sup> , mmol/l	138.6 ± 4.4	138.8 ± 2.2	140.6 ± 3.0	0.78/0.12
Serum K <sup>+</sup> , mmol/l	5.5 ± 0.7	5.5 ± 0.7	5.7 ± 0.9	0.60/0.12
<b>BIS data</b>				
Total body water, l	46.7 ± 6.1	47.3 ± 6.1	44.9 ± 4.3	0.16/0.34
Extracellular water, l	22.0 ± 3.1	22.9 ± 3.8	20.9 ± 2.7	<0.05/0.11
Intracellular water, l	24.1 ± 2.9	24.4 ± 2.5	24.0 ± 2.2	0.60/0.09
Ratio ECW/ ICW	0.90 ± 0.08	0.94 ± 0.09	0.87 ± 0.10	0.09/0.05

# Perspectives



42 patients 8-21 years,

Treatment with 3 or 4 weekly HDF since at least 3 months,  
Hypertension - Need for UF



Pre-HDF sNa between 133 and 143 mEq/L



4-week run-in period with dNa identical to the pre-dialysis  
sNa(138 to 140 mEq/L)

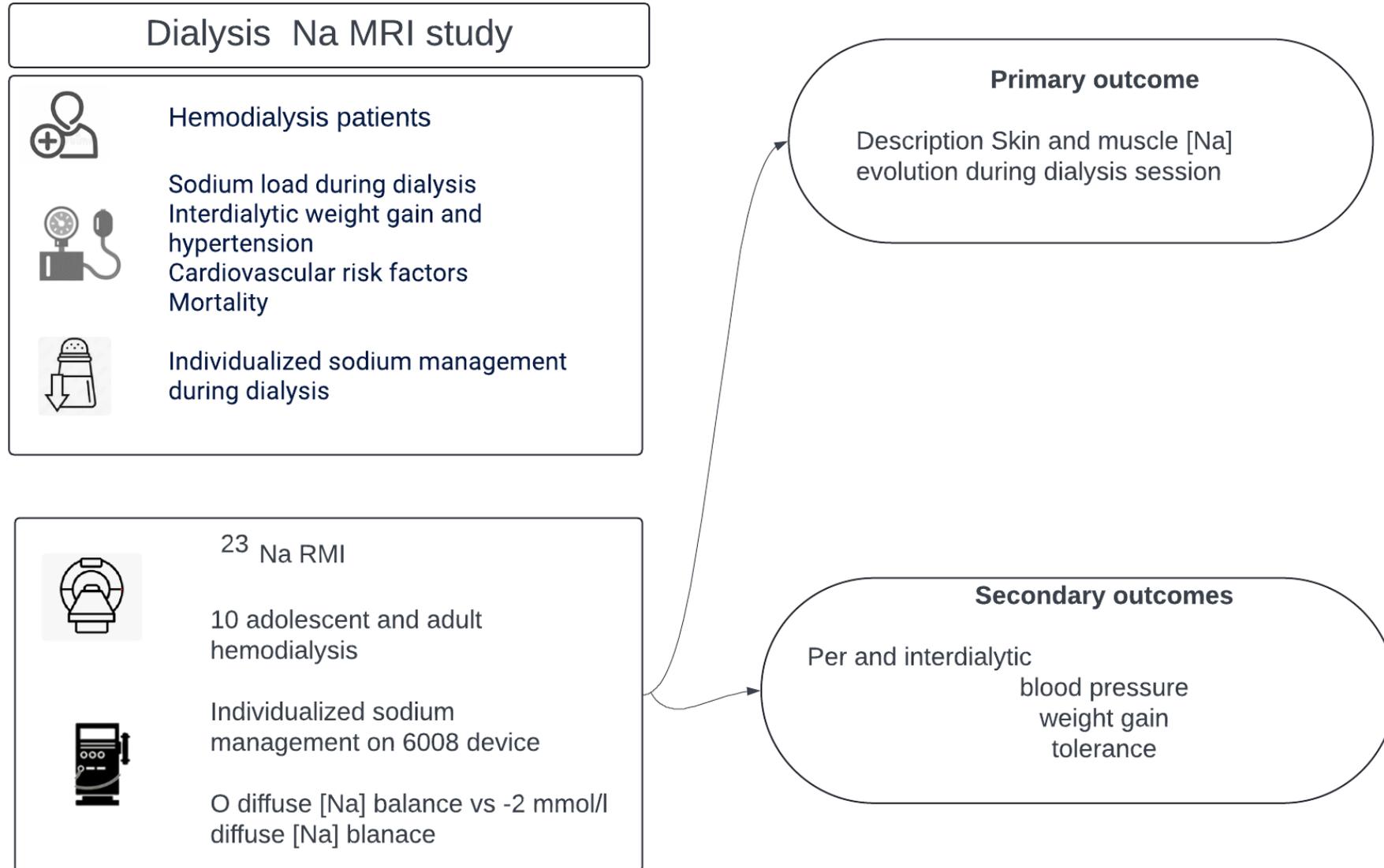
On day 28, patients will be randomized in two groups:



- Group A: low dNa -> dNa 5 mEq/l < pre-dialysis sNa (min of 133 and a max of 138 mEq/L), for a period of 6 weeks.
- Group B: standard dNa -> for a period of 6 weeks.

After the first phase (6 weeks) the patients will switch their dNa for the next 6 weeks (phase 2) in a crossover design

# Perspectives



## EN CONCLUSION

- Existence de sodium non osmotiquement actif
- Sodium non osmotiquement actif peut être visualisé par  $^{23}\text{Na}$  IRM
- Le sodium cutané semble être prédicteur indépendant des événements cardiovasculaires
- Le sodium cutané peut être mobilisable et être sensible aux interventions thérapeutiques
- $^{23}\text{Na}$  IRM outil personnalisé de prescription de la dialyse?
- Sodium cutanée: cible pour amélioration de la survie ?
- Etude sur plus grosse cohorte nécessaire mais problème d'accessibilité/ technicité de l'IRM

MERCI



[www.chu-lyon.fr](http://www.chu-lyon.fr)



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