

Lifestyle Management Strategies for Hemodialysis Patients

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What happens when your kidneys fail?

- Most common Treatment: hemodialysis 3 days/wk x 4 hours.
- Little urine produced
 - **Interdialytic weight gain ~ 2–3 kg/48 hr**
 - Leads to “chronic volume overload”, hypertension, LVH, CHF, CV mortality
- Other co-morbidities: Muscle wasting, bone disorders, depression...
 - **Med Rx: 19 pills/day (USA)**
- In USA, this costs Medicare: ~ \$93k/patient/year x 550K patients
 - Almost 1% of entire federal budget!
- **Patients do NOT feel they are being rehabilitated (have no hope)**



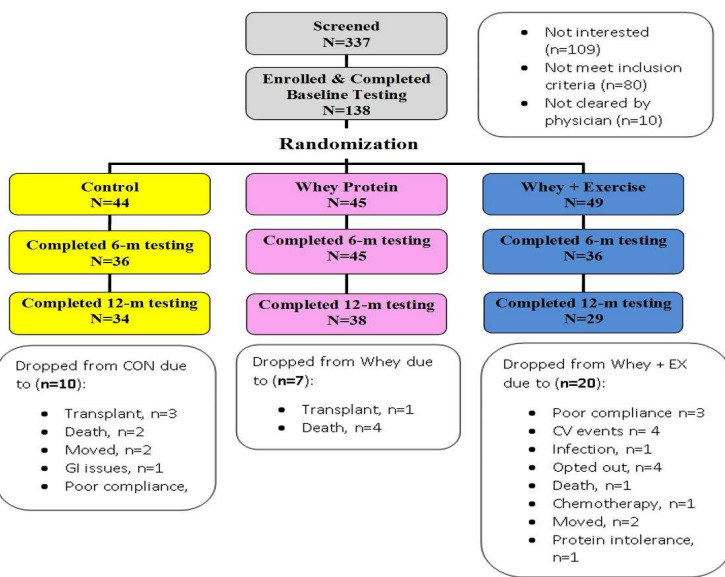
(Aneurysm from vascular access)



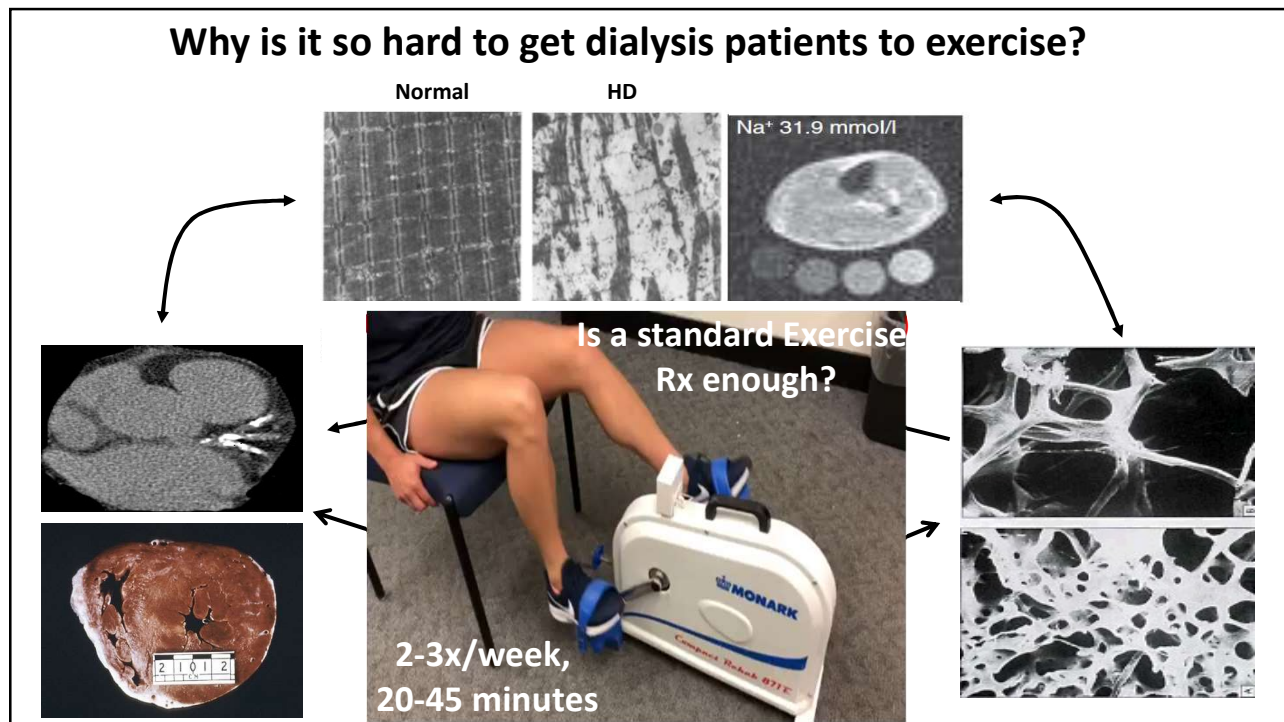
Case Study

- 55 year old African-American Male, on maintenance hemodialysis for 3 years
 - Obese (BMI = 32), Hypertensive (170/105), sedentary, poor physical function
 - Blood pressure meds: Amlodipine, Carvedilol, Losartan
 - IDWG ~ 3.1 Kg; chronic volume overload (per BIS analysis)
 - Dialysis-related symptoms include semi-frequent IDH, cramping, post-dialysis fatigue
- **What is a reasonable exercise Rx for this patient? And will it be effective?**
- **I will make the case for why a "typical" exercise program (e.g., intradialytic cycling, walking program, etc) are UNLIKELY to provide robust benefits.**
- **Why not?**
 - **1) Interest, exercise capacity, and compliance/adherence to an exercise Rx... are all likely to be low.**
 - **2) Patient has nutritional concerns that need to be addressed before they are capable of becoming more physically active**

What % of HD patients in Exercise Trials typically finish a program? (study consort from previous NIH trial)




- Age: 55 (29-81)
 - Gender: 58% male
 - BMI: 32 kg/m²
 - IDWG: 3.1 kg/48 hours
- Enrollment/dropout data:
 - 40% of those screened enrolled
 - 41% of exercise group dropped out
 - Summary: ~ 17% finished a 1 year exercise program
 - Even fewer adhere to Ex Rx (50%)...so now down to 8-9%
- ***Is exercise a good medicine if < 10% take an adequate dose?***



How much exercise are they actually doing?

Study	Frequency	Intensity/Time	Results	Comment/Calculated Work rate*
Koh 2010 RCT n=70	-3x/wk -6 months	-30-45 min IC -Mod intensity	-No Δ 6-min walk test or PWV	Avg Energy expenditure: End of study: 35 kcal/session
Kopple 2007 RCT, n = 80	-3x/wk -21 weeks	-20 -40 min IC -Mod intensity	-No Δ body comp. -Improved markers muscle metabolism	Avg energy expenditure: Baseline: 37 \pm 7 kcal/session End: 79 \pm 17 kcal/session
Bohm 2014 RCT, n=60	-3x/wk -24 weeks	-30 - 60 min IC -Low intensity	-No Δ VO ₂ peak, Or 6-min walk	Avg Energy expenditure: Baseline: 8W*30 min = 3.5 kcal/session End: 20W*60 min = 17.2 kcal/session
Toussaint 2008 X-over, n=19	-3x/wk -3 months	-30min IC -Self-determined intensity	Trend for improved PWV	Avg Energy expenditure: 73 kcal/session (throughout)
Manfedini 2017 "EXCITE"	-3x/wk -6 months	-20 min walking	Improved 6-min walk, STS, -hospital/mortality	*Total exercise/walking volume: IF FULLY ADHERENT= 60 minutes/week

An anecdote from my lab

- Patient (D.J.) ~ 35 year old A.A. male. Sedentary, obese, HTN, diabetes, IDWG ~ 5 kilos
- Randomized to EXERCISE group in IHOPE trial. Horrible compliance...
- Saw him one Monday.... IDWG was 15 kg
- Cramping Friday. Got saline, Got thirsty, DRANK THIS:
 
- Finished study... Saw zero benefits... we took bike away
- After 2-3 weeks, he asked for the bike back...Started cycling 1-2 hours/session, changed his diet... lost 40 pounds and got a transplant.
- DJ is contributing to the “negative” data from my NIH-funded RCT
- Take home message: this exercise stuff CAN work...if prescription/adherence is good

How is exercise “normally” prescribed in HD?



4 Primary steps:

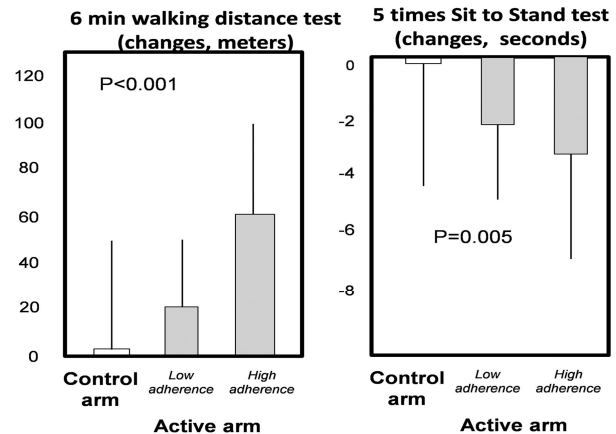
- 1) clinic purchases expensive bike
- 2) Nurse/tech sticks bike in front of patients 3x/week during dialysis
- 3) Beg patient to pedal
- 4) Give up. Watch bike collect dust in storage room
- Even if we could get them to pedal... would it matter?
- *Is this how YOU exercise?*

Despite these concerns, several recent trials provide reason for optimism:

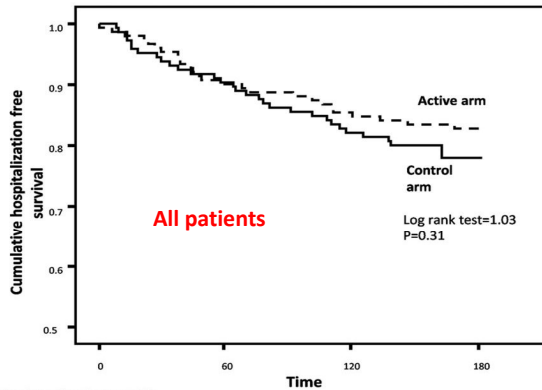
- 1) Both intradialytic exercise and an at home walking program improves physical function and reduces hospitalizations
 - EXCITE trial. Manfredini et al. JASN 2017 Apr;28(4):1259-1268
 - Anding-Rost et al. 2023. NEJM Evid. 2023 Sep;2(9)
- 2) Intradialytic cycling reduces LV mass
 - CYCLE HD trial. Graham-Brown et al. KI 2021 Jun;99(6):1478-1486
- 3) TWO studies showing intradialytic cycling (single bout) reduces myocardial stunning
 - Penny et al. NDT 2019 Nov 1;34(11):1917-1923
 - Mcguire et al. CKJ 2019 Dec 17;14(5):1335-1344

1) EXCITE Trial (Manfredini et al. JASN 2017 Apr;28(4):1259-1268)

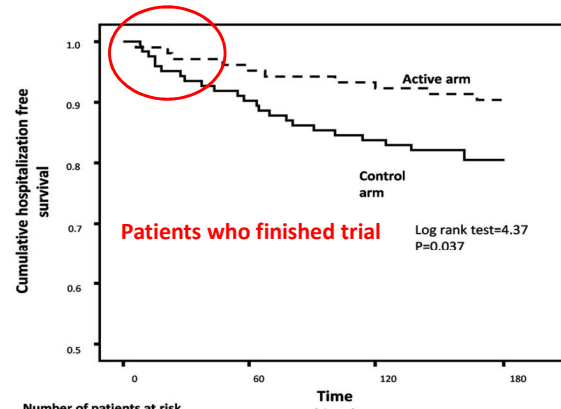
- 6 month RCT (**N = 227**)
- At home walking program
- Ex Rx: 20 minutes/day; 3 days/week
- Primary outcome: dose dependent improvements in physical function



EXCITE Trial secondary outcome: reduction in hospitalization?



Number of patients at risk	0	60	120	180
Active arm	151	136	128	125
Control arm	145	131	119	113



Number of patients at risk	0	60	120	180
Active arm	104	99	96	94
Control arm	123	111	103	99

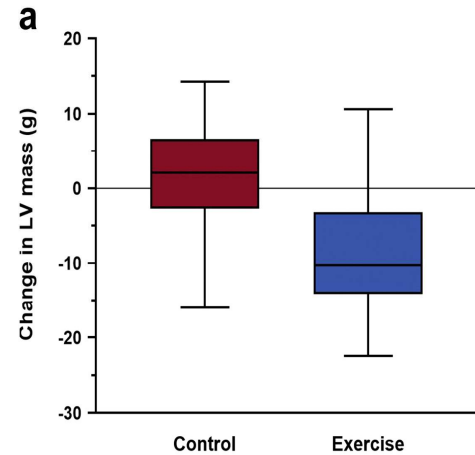
(Manfredini et al. JASN 2017 Apr;28(4):1259-1268)

Caveats to the EXCITE TRIAL

- Enrollment, dropout and adherence issues:
 - Only 41% of screened patients enrolled (typical)
 - 30% of exercise group dropped out before 6 months (typical)
 - ~ 50% of those were "highly adherent" (typical)
- Prescribed exercise dose was low
 - Prescribed dose was just 60 minutes walking/week (20 min 3days/week)
 - Realized dose averaged ~ half of that (~ 30 minutes of walking/week). **THIS IS TYPICAL**
- Summary: 41% enrolled x 30% dropout x 50% adherent = 6% of HD patients in the sample had good adherence to 60 minute/week walking program
 - Typical exercise guidelines are 150 minutes/week.
- Are improvements in 6-minute walk test (~ 39 meters) clinically significant?
- Hospitalization data is based on small sample, and most of the benefit was immediate?
- My take:
 - Nice study. Provides some evidence of potential benefits for physical function AND "hard outcomes" from a modest exercise Rx
 - But are benefits robust enough to change attitudes and/or policies toward exercise? And how can we get MORE to participate?**

2) CYCLE HD (Graham-Brown et al. KI 2021 Jun;99(6):1478-1486)

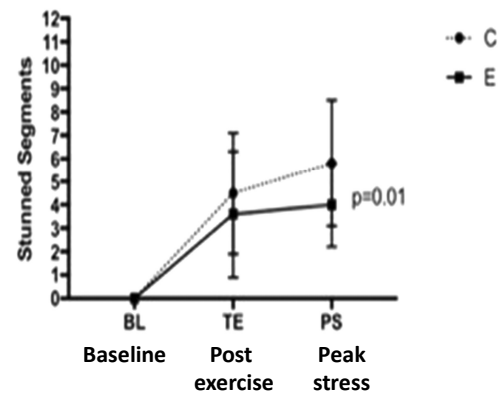
- 6 month RCT (N = 130), Intradialytic cycling, 30 minutes/day; 3 days/week
- Primary outcome:
 - LV mass reduced by 11g in cycling group vs control
- Secondary outcomes:
 - reduced arterial stiffness (good)
 - but no improvement in physical function or QOL (bad)
- My take: best intradialytic cycling trial to date, but will it change policy or practice?



3) Acute Effects of Intradialytic Cycling on Myocardial Stunning

Penny et al. NDT 2019 Nov 1;34(11):1917-1923

- Myocardial stunning assessed in 19 HD patients on two occasions:
 - Control day (dialysis with no exercise)
 - Dialysis with intradialytic cycling (30-60 minutes)
- Primary outcome:
 - # of "stunned segments" (RWMA) assessed by echo was reduced at peak stress (end of dialysis)
- My take:
 - Limitations: small, acute exercise study, needs confirmation w/ robust training study (in progress)
 - Positives: **Potential novel benefit of intradialytic cycling.** If confirmed, INTRADIALYTIC cycling should be included as a CORE component of comprehensive exercise interventions.

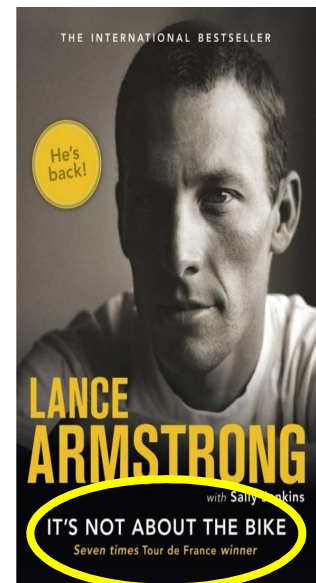


MY Summary of existing literature on exercise in HD

- Most of the existing literature shows modest benefits... but is flawed and uninspiring
 - Wilund et al. *Exerc Sport Sci Rev.* 2020 Jan;48(1):28-39
- Several recent trials have provided more hope:
 - Manfredini (EXCITE trial); Anding-Rost; and Graham-Brown (CYCLE-HD). (robust RCTs)
 - 2 pilot studies showing reduction in myocardial stunning with acute exercise
- But other recent robust RCTs have not shown many benefits (not shown here):
 - Jeong et al. *Kidney Int.* 2019 Sep;96(3):777-786 (IHOPE trial - my lab)
 - Koh et al. *Am J Kidney Dis.* 2010 Jan;55(1):88-99 (Australia)
 - Greenwood et al. *HTA.* 2021 Jun;25(40):1-52. (PEDAL trial – UK)
 - *Summary of these 3: no changes in physical fx, arterial stiffness, and/or QOL*
- **Summary:** “Exercise in HD has many documented benefits... with lots of caveats”. (My opinion)
- Regardless of how the literature is interpreted, **IMPLEMENTATION REMAINS LOW.**
- So how to move forward?

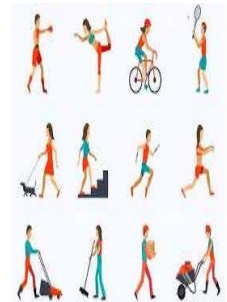
What is “trending” (and not) in exercise in HD?

- Not trending:
 - Small studies with boring, mandated exercise prescriptions. *Nobody seems to care*
 - IMO: The days of sticking bikes in front of dialysis patients and calling it an exercise Rx needs to stop
- Trending:
 - Larger studies (including international collaborations through the Global Renal Exercise (GREX) network)
 - Important/relevant Outcomes: a) PROMS; b) “hard” outcomes; c) novel outcomes (e.g. myocardial stunning, muscle sodium); d) cost-effectiveness analyses (can clinics and/or dialysis providers SAVE \$)
 - Incorporating technology (e.g., virtual reality, activity trackers), including for remotely delivered programs
 - Exercise/physical activity Rx focused on “MOVING MORE”, instead of mandated exercise
 - Interventions that are “comprehensive” (lifestyle medicine approach, as opposed to just exercise)

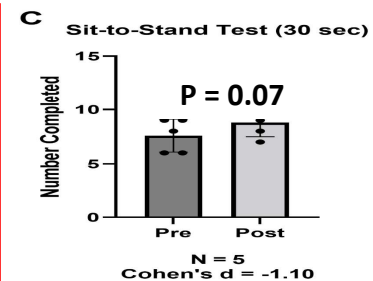
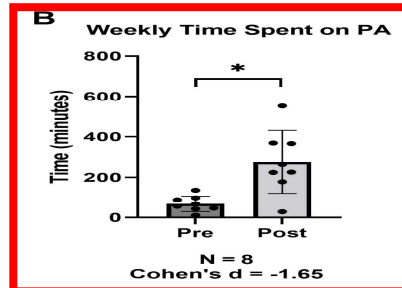
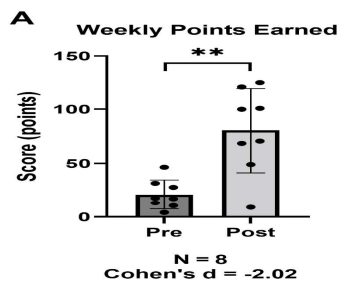


Instead of mandating specific exercises, *should we focus on just trying to get our patient to MOVE MORE?*

- Pilot study - Primary Aim:
 - Examine feasibility/efficacy of a novel, patient-centered exercise/physical activity Rx in HD patients on physical activity, function, and QOL
- Methods:
 - Comparative effectiveness trial- comparing: 1) intradialytic cycling to 2) “Move More” approach
 - 12 weeks, including weekly one-on-one sessions with interventionist to motivate, set goals, etc
 - **All movement counts:** points-based system based on energy expenditure (METs) for activities
 - E.g., slow walking is 3.0 METs.... So get 3 points for every 10 minutes walked
 - Raking leaves is 4.0 METs... so get 4 points for every 10 minutes raking leaves...
 - Program is progressive. Goal is to increase weekly points... based on individual capability
 - Engaging patient’s family (to help motivate)
- Goal: Build habits and the support structure that allows exercise to work, and make it sustainable



Prelim Results from a “Covid-limited” 6 week pilot “Move More” PA program



- 5x ↑ in Physical Activity
- Better than intradialytic cycling... but still low

- Move More Phase II (Post-Covid do-over): Status- Ongoing: N = 35 (planned enrollment)
- Robust “Move More” type trials underway or planned in Australia... and in Europe

Selected Barriers to Exercise/moving more in HD

We can try any strategy we want... but many patients will still struggle to exercise, b/c of:

- 1) Poor physical function
- 2) Fatigue
- 3) Cramping
- 4) Depression... etc
- **5) Chronic Volume Overload/IDWG (and related CV comorbidities)**
 - Directly or indirectly affects many other barriers to exercise in HD
 - The more fluid that has to be removed during dialysis, the worse these symptoms
 - Exercise in 3rd/4th hour of dialysis is contraindicated due to cramping/IDH concerns
 - **VO may also contribute to excessive tissue Na retention, which may adversely impact muscle function**
- Individually and collectively, these barriers have huge impact on ability/willingness to exercise DURING dialysis OR out-of-clinic



Your tests reveal that you are retaining fluids!

Fluid and Sodium Retention



²³Na-MRI

Why Controlling IDWG/Volume Overload is so Critical for Exercise

- The lower the IDWG, the lower the UF rate
- If IDWG is high (e.g., 4 liters), UFR ~ 1L/hour, which is faster than the plasma “refill rate” for most patients
 - Result: IDH, ischemia, myocardial stunning, cognitive dysfunction, post-dialysis fatigue, sleeplessness, depression...
 - **The “sledgehammer of dialysis”**
- If IDWG is low (e.g., 2 liters), UFR ~ 0.5L/hour, and plasma refill rate is ~ sufficient to maintain BP
 - Result: stable BP, less cramping/fatigue... **greater capacity to exercise**
 - A more “gentle” dialysis
- How do you lower IDWG and chronic volume overload?
 - **Reduce salt intake to prevent thirst... is a good start**

Dialysis following high IDWG



Dialysis following low IDWG



Evidence it is hard to exercise if have volume overload

- Moore et al AJKD 1998 Apr; 31(4): 631-7
- This study represents the scientific rationale for not cycling late in dialysis
- 8 patients cycled for 5 minutes at 0, 1, 2, and 3 hours into dialysis
- 5/8 could not cycle in 3rd hour
 - those with highest UF volume
- Volume overload is a significant barrier to exercise DURING dialysis
- Volume overload-induced cramping, fatigue also contribute to reduced exercise/movement OUTSIDE the clinic

Table 1. Fluid Removed v Cycling Status

Subject	Starting Weight (kg)	Weight at 2 hr (kg)/Fluid Removed (mL)	Weight at 3 hr (kg)/Fluid Removed (mL)	Status at 3 hr
1	74.5	72.7/1,600	72.5/2,400	Cycled
2	79.0	77.3/1,890	76.6/2,690	Cycled
3	83.4	NA*/3,850	NA/6,020	Orthostatic
4	95.0	92.4/2,940	91.0/4,420	Cycled
5	82.2	79.3/3,340	NA/4,320	Orthostatic
6	108.4	104.7/4,340	NA/5,860	Orthostatic
7	64.5	62.6/2,150	NA/2,870	Felt "shaky"/declined cycling
8	64.3	61.9/2,840	60.9/3,920	Cramped while cycling

*Subject 3 had abdominal cramps at 2 hours and could not stand for weighing, but did cycle.

Even modest UF rates are problematic...

Table 3. The effect of increasing ultrafiltration (UF) volume and worsening intradialytic haemodynamics on the development of HD-induced RWMA's

Factor associated with presence of myocardial stunning	Odds Ratio	P value
UF volume during HD of 1L	5.1	0.007
UF volume during HD of 1.5L	11.6	
UF volume during HD of 2L	26.2	
Maximum SBP reduction during HD of 10 mmHg	1.8	0.002
Maximum SBP reduction during HD of 20 mmHg	3.3	
Maximum SBP reduction during HD of 30 mmHg	6.0	

Burton et al. CJASN 4: 914–920, 2009

Take home message: even MODEST UF volumes may cause ischemia/myocardial stunning... so efforts should be made to reduce IDWG to extent possible in all patients

- by managing SODIUM INTAKE... and NOT with fluid restrictions

If we want to truly rehabilitate HD patients, we must minimize volume overload

- **VO: one of the most perplexing problems in Nephrology**
 - Increases BP, LVH, CHF, and CVD mortality
 - Promotes intradialytic hypotension and cramping
 - **It also inhibits physical activity in many patients (observation)**
- **How Prevalent is it?**
 - ~ 25-80% in different studies
- **What to do about it?**
 - **VO can be nearly eliminated using intensive volume control strategy practiced in Izmir, Turkey (and a few other places)**

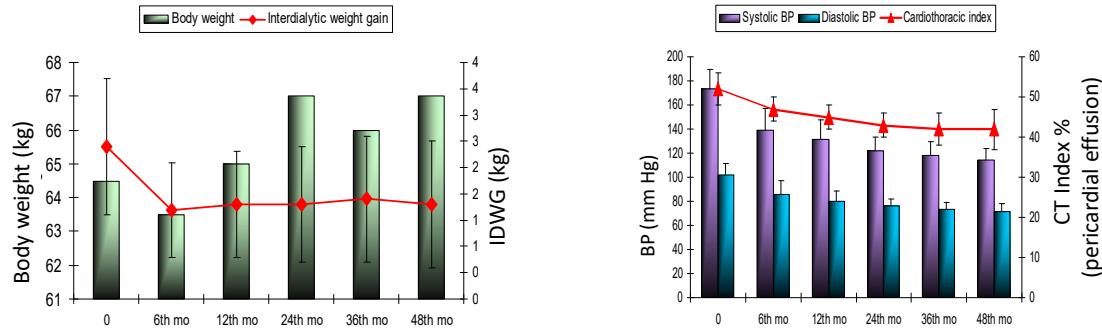


Izmir's Remarkable Data



- ~ 90-95% of Hemodialysis patients in Izmir have **NORMAL BP** (~ 120/80) ***with No B.P. Medications!***
- IDWG averages < 2.0L
- Systolic and diastolic function are normal, LVH and heart failure are rare
- Mortality rate is ~ half of what it is in the U.S.
- Dialysis Prescription is **standard**: 3 days per week, for 4 hours/session.
- How do they accomplish this... *and why is nobody else doing it?*

Initial Results from Volume Control Strategy in Izmir

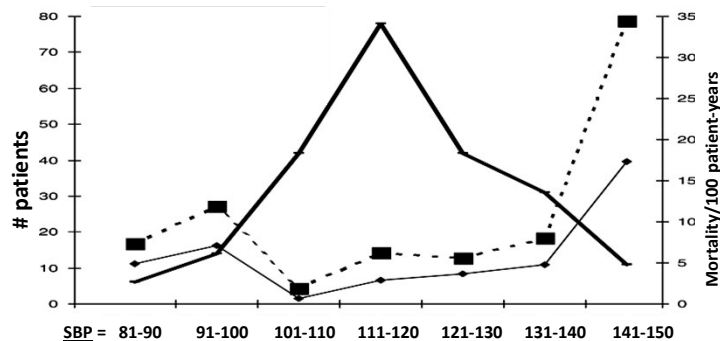


- 67 hypertensive HD patients on BP meds; avg age 42y
- Improved IDWG, body mass, BP and CTi (above)
- Increase in hemoglobin and serum albumin levels (hemoconcentration?)
- Only 4% need BP meds
- Zero patients with edema and heart failure

Ozkahya M et al. Am J Kidney Dis 1999; 34: 218-21

Izmir Volume Control also Associated with Low hospitalization & Mortality

- N = 218 HD patients, avg. follow-up = 47 months after VC implemented
- IDWG ↓ from 1.4 kg/d to 0.9 kg/d
- Mean BP ↓ from 150/89 to 121/76 mmHg; Only 9 patients on BP meds
- 1 of 210 prevalent patients hospitalized with hypervolemia in 1 year
- Annual Mortality rate = 6.8%; **Lowest Mortality with SBP= 101-110 mmHg**

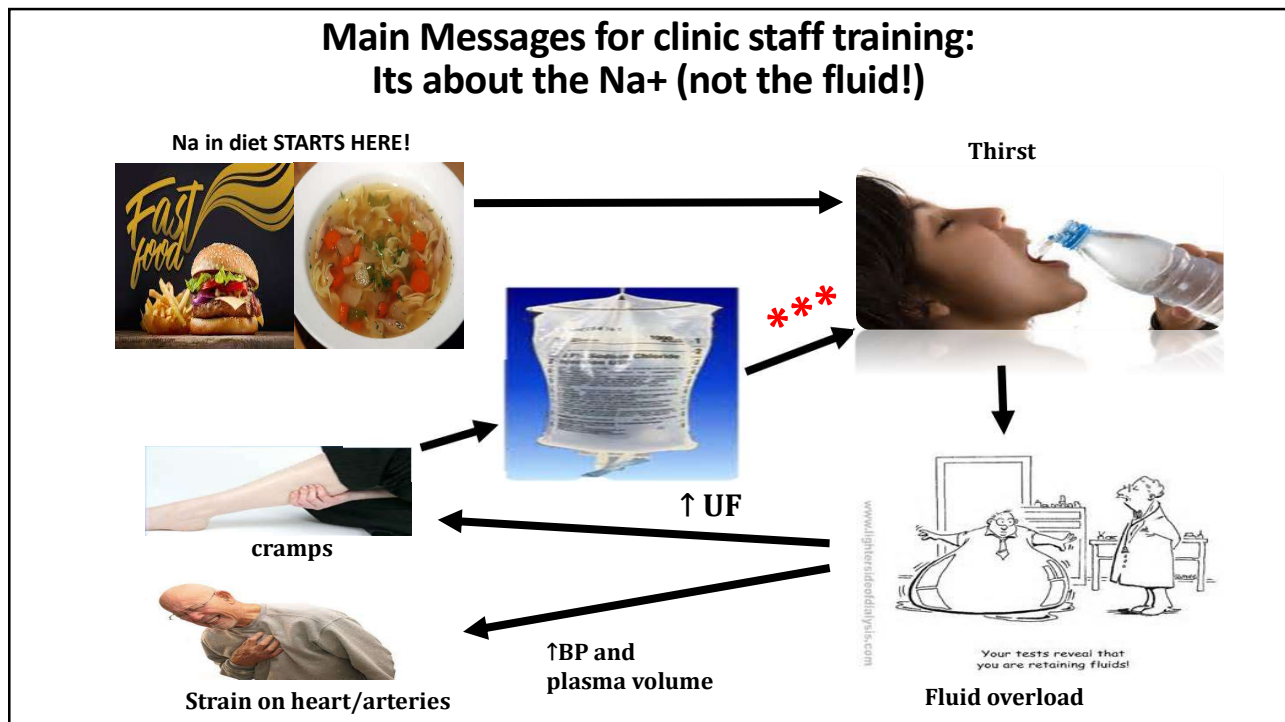


Ozkahya et al. NDT 2006; 21: 3506-13

USA (and most the world) "Pharmacological" approach	Policy/Practice	Izmir, Turkey (and Tassin France...) "Comprehensive Volume Control protocol"
2-3 BP meds/patient (vasodilators, B-Blockers, ARBs, ACEi...)	BP Medications	BP meds rarely used (10%) (b/c they promote interdialytic <u>HYPO</u> tension)
Focus on P, K -confusing and ineffective restrictions	Primary Diet restrictions	Focus on Na (to prevent thirst) -sensible restrictions: eat less processed food
Tell thirsty patients not to drink so much (< 1 L/d)	Fluid intake policy	Allow patients to "Drink as thirst indicates" (restrict Na... to prevent thirst)
RDs provide counseling (~1 RD/100 patients)	Dietary Counseling	RDs, Nephrologists, nurses, receptionists, bus drivers... Reinforce a low-Na message
Provide IV Saline/stop removing fluid	Cramping/intradialytic hypotension	Provide IV dextrose/massage cramps
Hypertension in 80% of patients w/ 2-3 BP meds	RESULTS	Normal BP in 90% of patients w/ ZERO BP meds -CV mortality is HALF of U.S. rate
Which patient population do you think has a greater capacity to exercise?		
<u>If we want to rehabilitate HD patients, this should be our target!</u>		


How does Izmir get patients to eat less salt?

- "Immerse clinics in a culture of Na⁺ restriction"
 - Mediated by clinic staff
 - Minimize restrictions on P and K *in most patients*
- Rationale: a single RD cannot handle this problem
- Clinic staff (nurses/techs...) need to be trained to help deliver the low Na⁺ message
 - In Izmir, the BUS DRIVERS are taught how to promote the low Na message
 - We have developed a "workplace wellness program" to help facilitate this
- Izmir approach: relies on CONSTANT communication with the patients
 - EVERYTIME a patient comes in with elevated BP or IDWG... they get counseled by the staff
 - "Its not enough to tell them once!"



Guiding Principles for low Na intake (rules we reinforce to staff & patients)

1. **Shop More**
 - Getting family involved
2. **Shop Better**
 - Shop for “whole foods”, liberalize dietary restrictions on P and K
 - Grocery shopping tours
 - Label reading (1 mg Na/kcal rule)
3. **Eat out less**




Nutrition Facts	
2 servings per container	
Serving size 1 piece (50g)	
Amount per serving	
Calories 210	
Total Fat 6g	8%
Saturated Fat 1g	5%
Trans Fat 0g	
Polyunsaturated Fat 0.5g	
Monounsaturated Fat 4g	
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 37g	13%
Dietary Fiber 1g	4%
Soluble Fiber 0g	
Insoluble Fiber 0g	
Total Sugars 15g	
Includes 13g Added Sugars	26%
PROTEIN 3g	
Vitamin D 0mcg	0%
Calcium 6mg	0%
Iron 1mg	6%
Potassium 56mg	2%
Thiamin 0.2mg	15%
Riboflavin 0.1mg	8%
Niacin 2mg	3%
Magnesium 8mg	2%

“The 1mg Na+/Kcal Rule”

> 1 mg/kcal

Nutrition Facts	
Serving Size 1 Bag (1g)	
Servings Per Container 1	
Amount Per Serving	
Calories 250	Calories from Fat 90
% Daily Values*	
Total Fat 10g	15%
Saturated Fat 4g	20%
Trans Fat 0g	
Cholesterol 100mg	33%
Sodium 440mg	18%
Total Carbohydrate 38g	13%
Dietary Fiber 2g	8%
Sugars 0g	
Protein 2g	4%

*Percent Daily Values are based on a 2,000 calorie diet.

Na/kcal = 440/250 > 1 (**BAD**)

< 1 mg/kcal

Nutrition Facts	
Serving Size 1 Cup (1g)	
Servings Per Container 1	
Amount Per Serving	
Calories 300	Calories from Fat 108
% Daily Values*	
Total Fat 12g	18%
Saturated Fat 3g	15%
Trans Fat 0g	
Cholesterol 120mg	40%
Sodium 130mg	5%
Total Carbohydrate 45g	15%
Dietary Fiber 5g	20%
Sugars 0g	
Protein 4g	8%

*Percent Daily Values are based on a 2,000 calorie diet.

Na/kcal = 130/300 < 1 (**GOOD**)

“Is the sodium # bigger than the calorie #?”

I taught 75% of these people how to shop using the 1mg/kcal rule



My lab's 1st attempt to mimic the Izmir Volume Control Protocol

- 23 patients completed 6-month volume control protocol (modeled after Izmir):

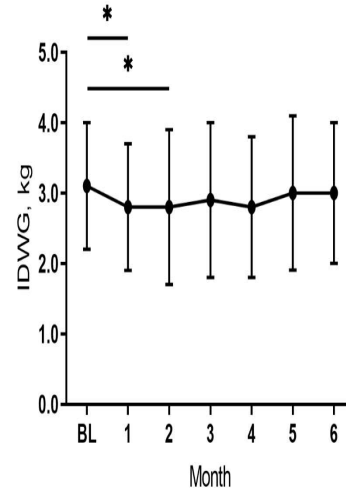
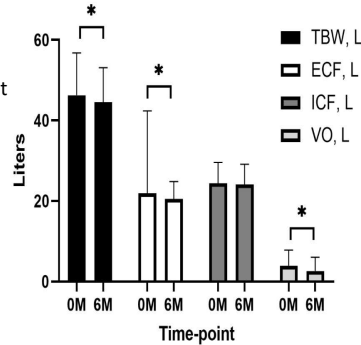
- 1) Weekly counseling to reduce dietary Na and IDWG
 - **Patients didn't listen**
- 2) BP medication de-prescribing
 - **physicians were hesitant**
- 3) Persistent reduction of post-dialysis weight
 - **nurses refused**

- Main outcomes (despite problems):**

- Significant Reduction in VO at 6 months
- Short term (2 month) reduction in IDWG

- Conclusions:**

- Our VC protocol produced MODEST benefits
- **Must find way to get more buy in from clinic staff and patients**



Perez, Hem Int 2020 Jul; 24(3): 414-422.

Next Step: "Just Feed Them" (instead of low-Na counseling) (and worry about the clinicians later)

- Rationale:** Low Na+ counseling often fails (everywhere).

-Can we reduce IDWG by providing low-sodium meals?

- Study Design:**

- N = 20 HD patients
- **Weeks 1–4:** usual (control) diet
- **Weeks 5–8:** deliver 3 low-Na meals/day to home
- **Primary outcome:** change in IDWG

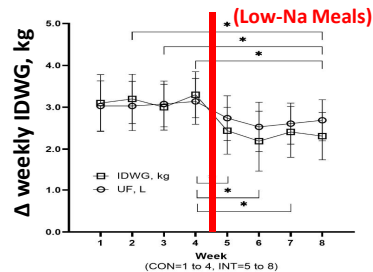
- Results:**

- 1) IDWG and Volume Overload reduced
- 2) SBP (-18mmHg) and DBP (-6mmHg) reduced
- 3) Thirst and Xerostomia scores improved (less candy!)

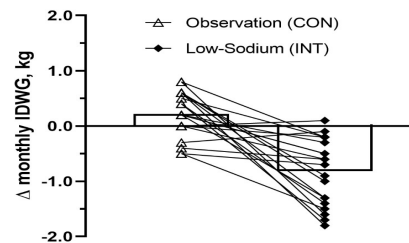
Summary: promising prelim study. Can benefits be maintained?

Answer: NO!

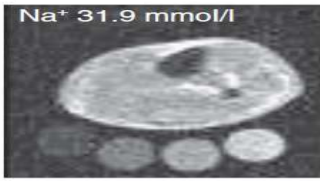
- We repeated study using 3 months of delivered meals.
- Benefits waned after first month
- (Significant meal fatigue)



Perez Hem. Int. 2021 Apr;25(2):265-74



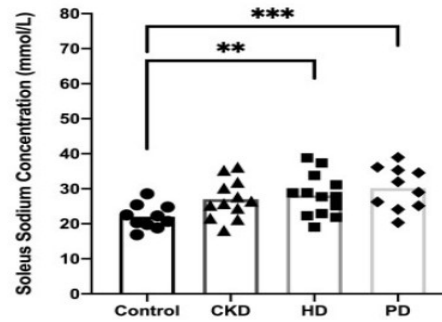
Another reason to reduce dietary sodium: reduce salt in the muscle



²³Na-MRI

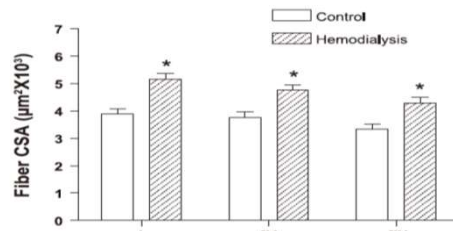
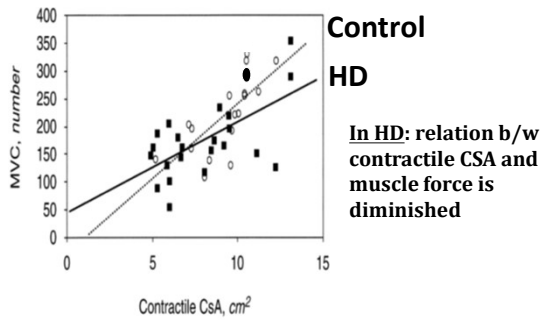
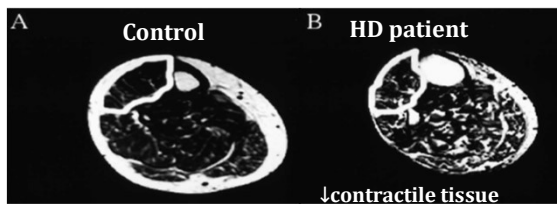
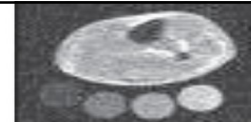
- As we age... and in certain chronic diseases, salt accumulates in soft tissues
- “New” understanding of sodium metabolism:
 - Classic physiology: dietary Na is excreted in the urine in 24h (false)
 - **Instead, dietary Na is temporarily stored in tissues (²³Na-MRI studies)**
 - Immune cells detect stored Na, promoting lymph vessel expansion to remove the stored Na
- **With age and disease (including CKD)... Na clearance from tissues is reduced**

http://www.kidney-international.org mini review
 © 2013 International Society of Nephrology
Spooky sodium balance
 Jens Titze^{1,2}, Anke Dahlmann¹, Kathrin Leichl¹, Christoph Kopp¹, Natalia Rakova^{1,3}, Agnes Schröder¹ and Friedrich C. Luft^{2,3}



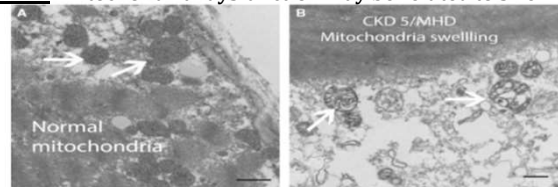
McIntyre. NDT (2006).

Does excessive muscle Na contribute to the muscle wasting and dysfunction in HD patients?



In HD: Enlarged muscle fiber may indicate fiber edema

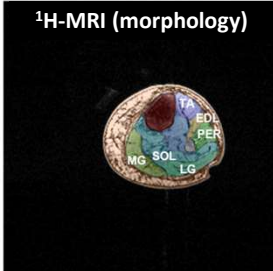
In HD: mitochondrial dysfunction may be related to swelling



Johansen. Kidney Int (2003); Lewis. J Appl Physiol (2012)

²³Na-MRI Analysis can distinguish total, intra and extracellular Na in muscle


A



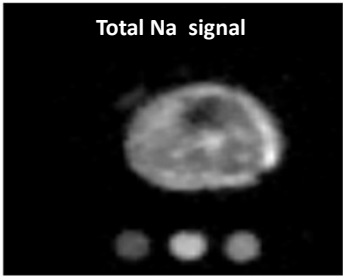
¹H-MRI (morphology)

6 Muscle beds:

- 1) MG: Medial Gastrocnemius
- 2) LG: Lateral Gastrocnemius
- 3) SOL: Soleus
- 4) TA: Tibialis Anterior
- 5) EDL: Extensor Digitorum Longus
- 6) PER: Peroneal Muscles

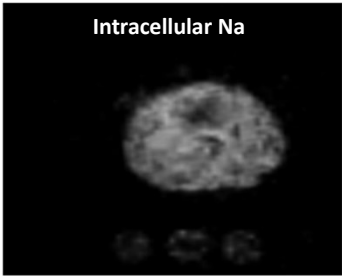


B



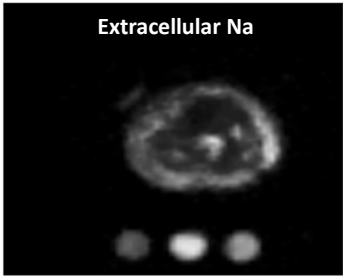
Total Na signal

→



Intracellular Na

+

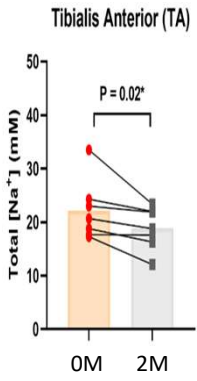


Extracellular Na

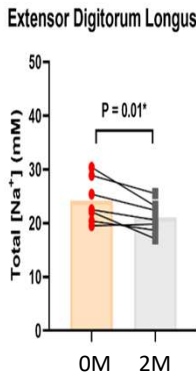
Addressing barriers: can dietary Na restriction remove Na from muscle... and improve physical function?

2-month pilot study - provided 3 low Na meals/day

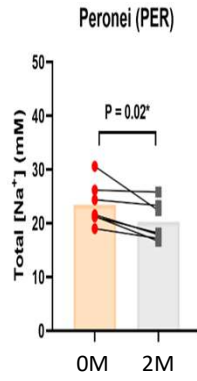
Tibialis Anterior (TA)



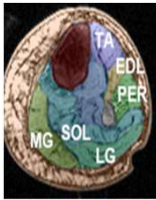
Extensor Digitorum Longus (EDL)




Peronei (PER)



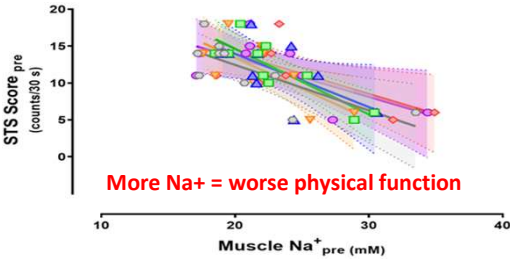
Intriguing preliminary data... needs confirmation.



¹H-MRI



²³Na-MRI



More Na+ = worse physical function



1) Developing Patient Gardens

Next Steps: *Instead of telling patients what they can't eat... or just feeding them... we instead want to help teach them to:*

- 1) **Grow** food (esp herbs/spices)
- 2) **Shop** better (focus on Na)
- 3) **Cook** healthier (focus on Na)

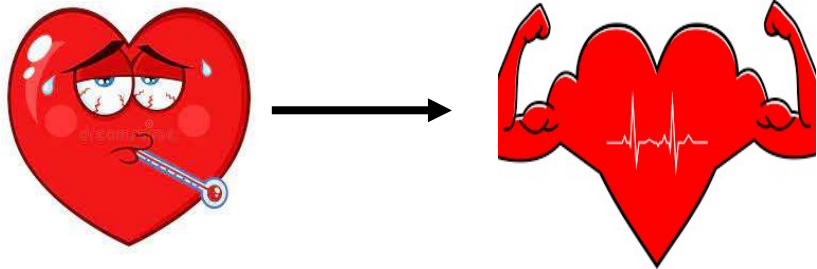


3) Renal Culinary Med program



2) VR low-Na education

Purpose: reduce Volume Overload and improve CV health (improve exercise capacity)



Development and Testing of VR-based Low-Na education program

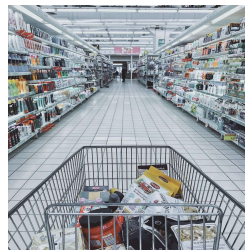
Old Approach: Low-Na counseling/meal provision: Producing modest ↓ in Na intake, BP, and muscle Na

New Approach: Developing VR app to supplement low sodium education

5 VR Modules being developed

(focus on ↓ Na+)

- 1) Meal planning
- 2) Label reading
- 3) *Grocery store tour
- 4) Food storage
- 5) Cooking tips



Goals:

-Gamify (and simplify) Low Na+ education for HD patients

-Reduce chronic volume overload

-Reduce muscle sodium:



²³Na MRI

Current focus of low Na+ education is on growing, shopping, and cooking (and the value of eating together)



Gardens



Kitchen



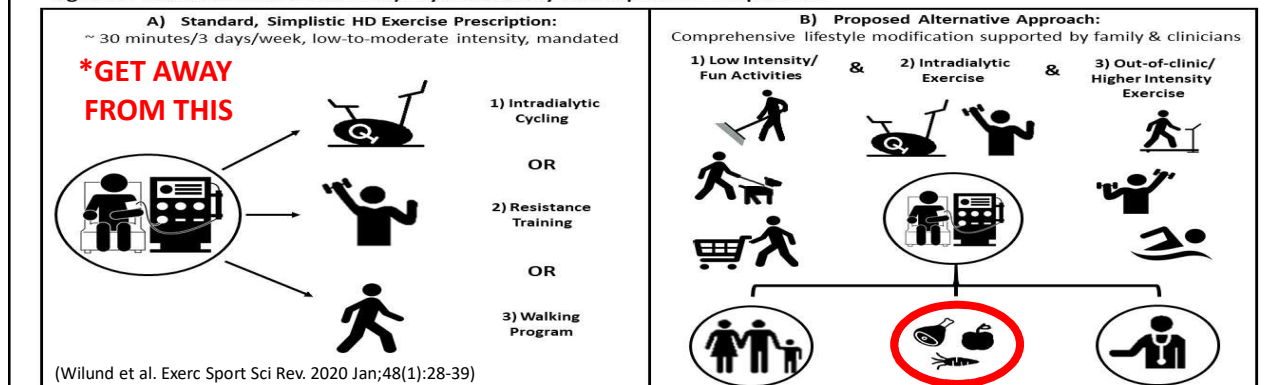
Eating Together

- Tucson Village Farms has programming focused on kids (4H program) and their families.
- I am setting up study to extend this programming for chronic disease (CKD)
- Will include classes on growing, shopping, and cooking (6 classes) for patients and families

Summary: We need comprehensive lifestyle interventions to prevent the cycle of disease and disability in HD!

- 1) We need to move away from mandated exercise Rx's, and focus on getting patients to MOVE MORE
- 2) For ROBUST improvements in health and QOL, we must also address chronic volume overload and muscle sodium... and many other problems. (lifestyle medicine approach)
- 3) This will help get HD patients healthy enough to exercise more!

Figure 1: Standard vs Novel Exercise/Physical Activity Prescription for HD patients



Questions?

**Cardiovascular
Health and
Well-being**
a dietetic practice group of the
**Academy of Nutrition
and Dietetics**
eat
right.

