



ANTE
Associazione Nazionale Tecnici Emodialisi

XXXI Corso Nazionale ANTE - Dialisi e Tecnologia
**“Evoluzione tecnologica nei trattamenti dialitici cronici e acuti:
dalla teoria alla pratica”**

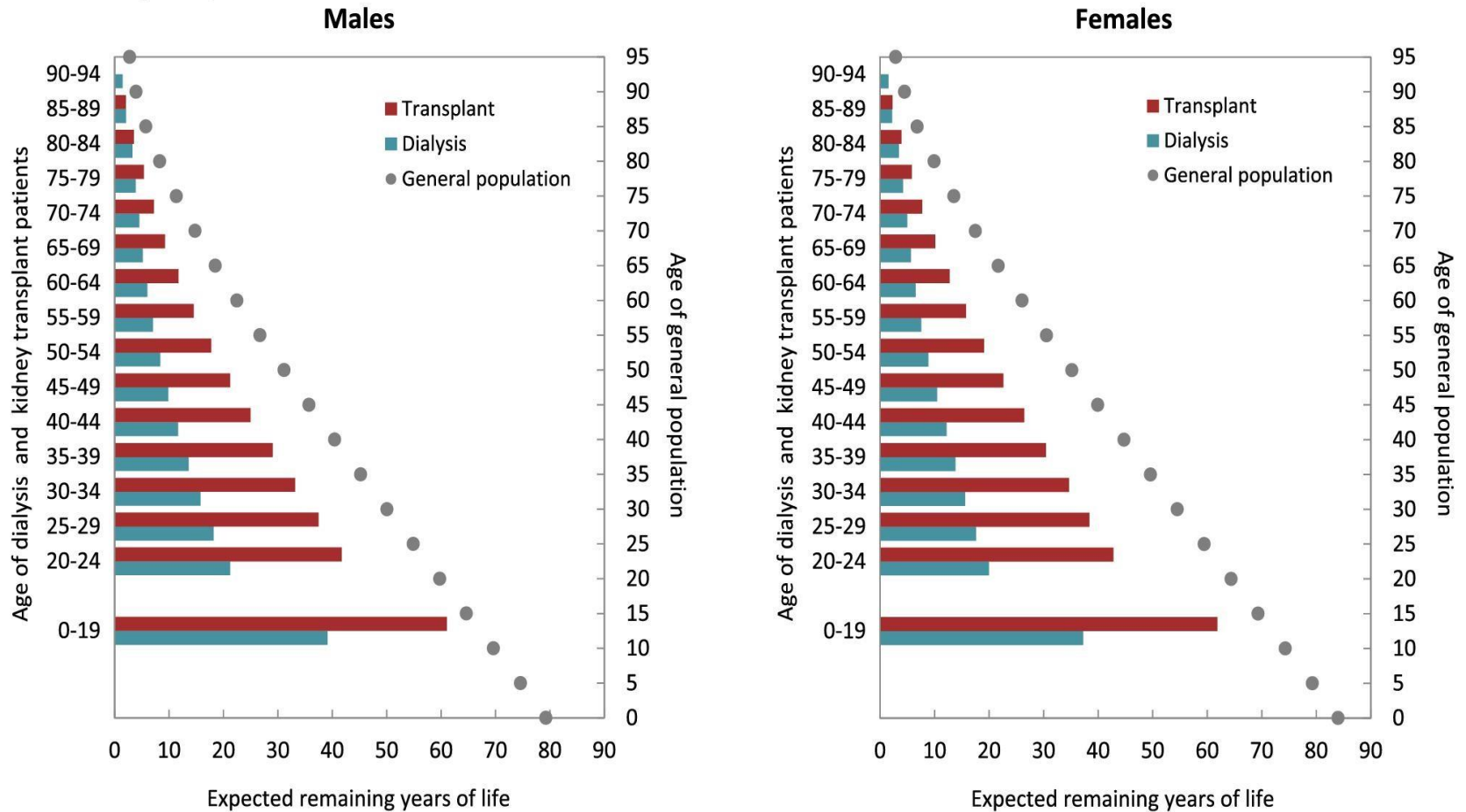
RICCIONE, 15-17 aprile 2024

**Membrane modificate e biofunzionalizzate:
avanzamento biotecnologico e indicazioni cliniche**

Emanuela Mangione

Aspettativa di vita in dialisi

Expected remaining years of life of the general population and of prevalent dialysis and kidney transplant patients



Emodialisi: pubblicazioni

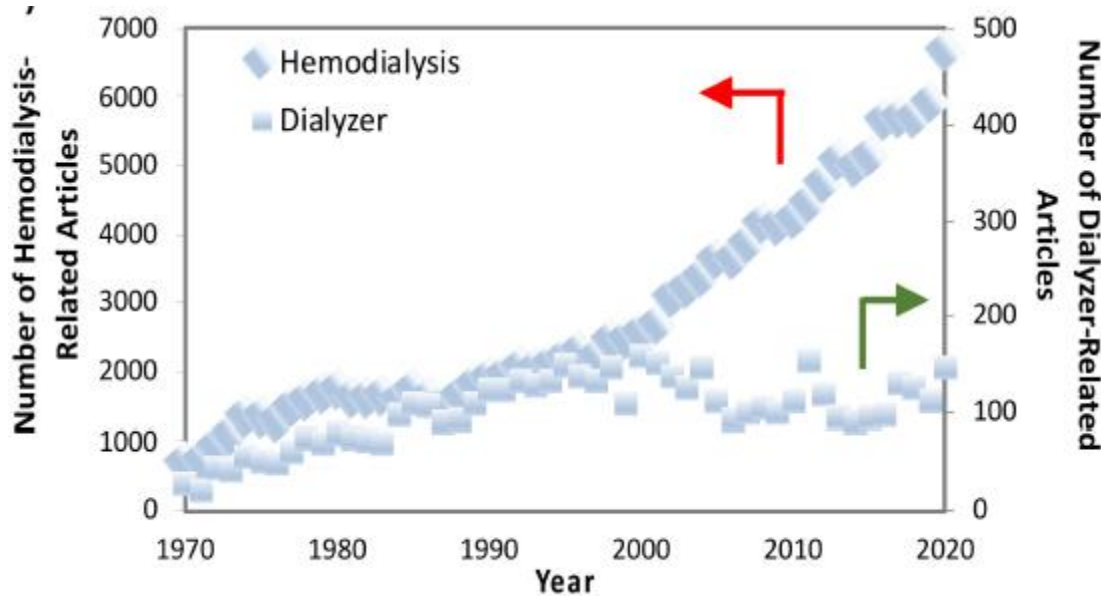
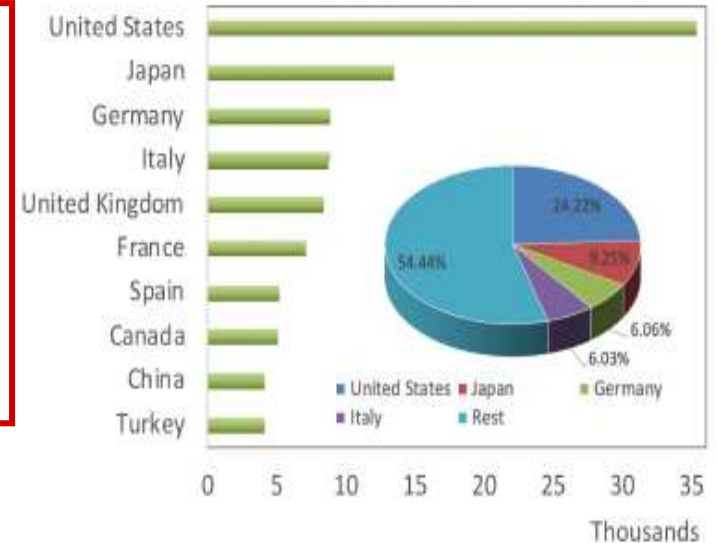


membranes



Review
A Review of Commercial Developments and Recent Laboratory Research of Dialyzers and Membranes for Hemodialysis Application

Noresah Said¹, Woei Jye Lau^{1,*}, Yeek-Chia Ho², Soo Kun Lim³, Muhammad Nidzhom Zainol Abidin¹ and Ahmad Fauzi Ismail¹

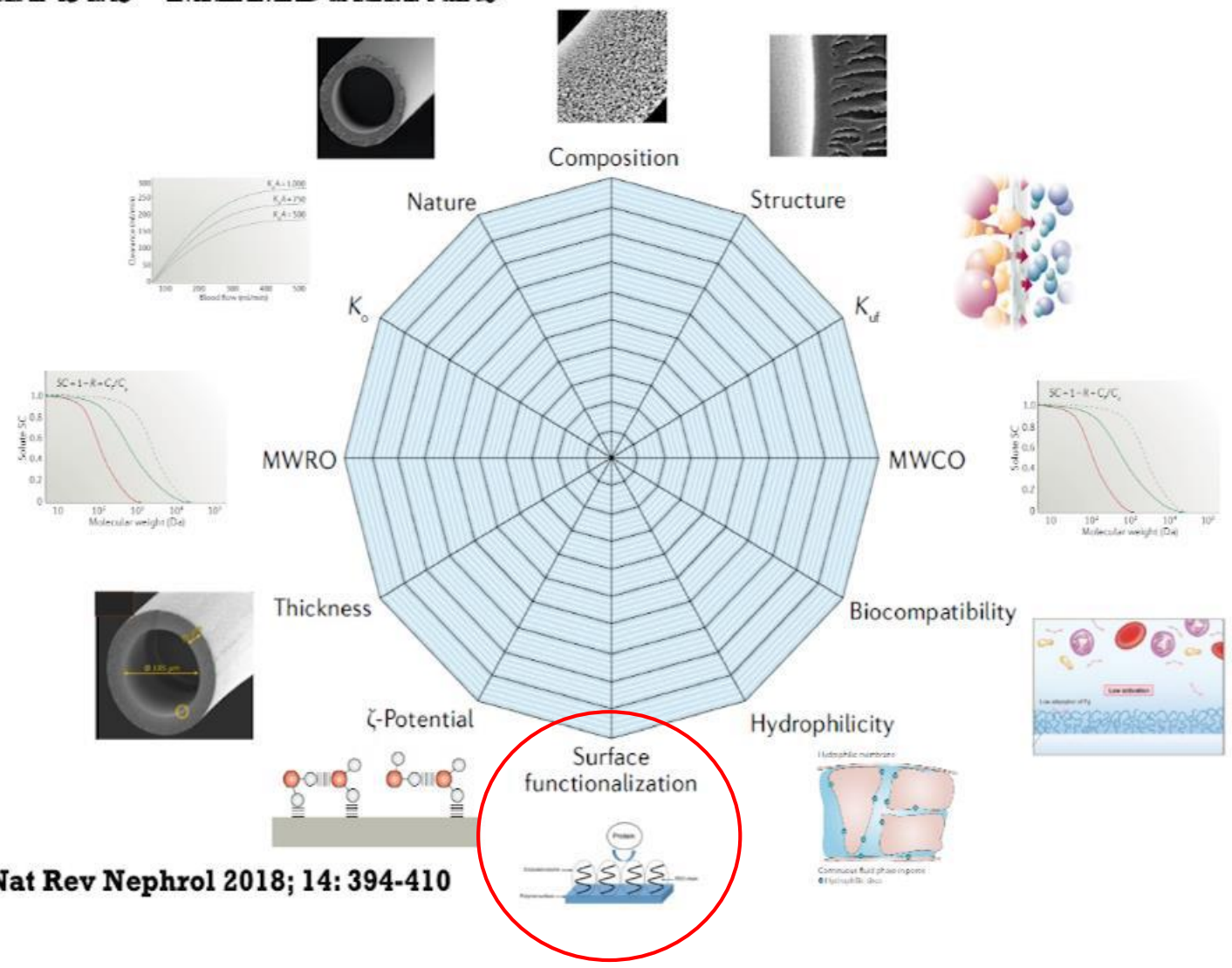


Number of Hemodialysis-Related Articles



Number of Dialyzer-Related Articles

MULTIDIMENSIONAL CLASSIFICATION OF DIALYSIS MEMBRANES



Ronco C, Clark WR. Nat Rev Nephrol 2018; 14: 394-410

Biocompatibilità dei materiali

Consensus conference on biomaterials, Chester, UK - 1986

Biocompatibilità

“Abilità di un materiale utilizzato per una data applicazione di agire determinando una risposta appropriata nell’ospite”

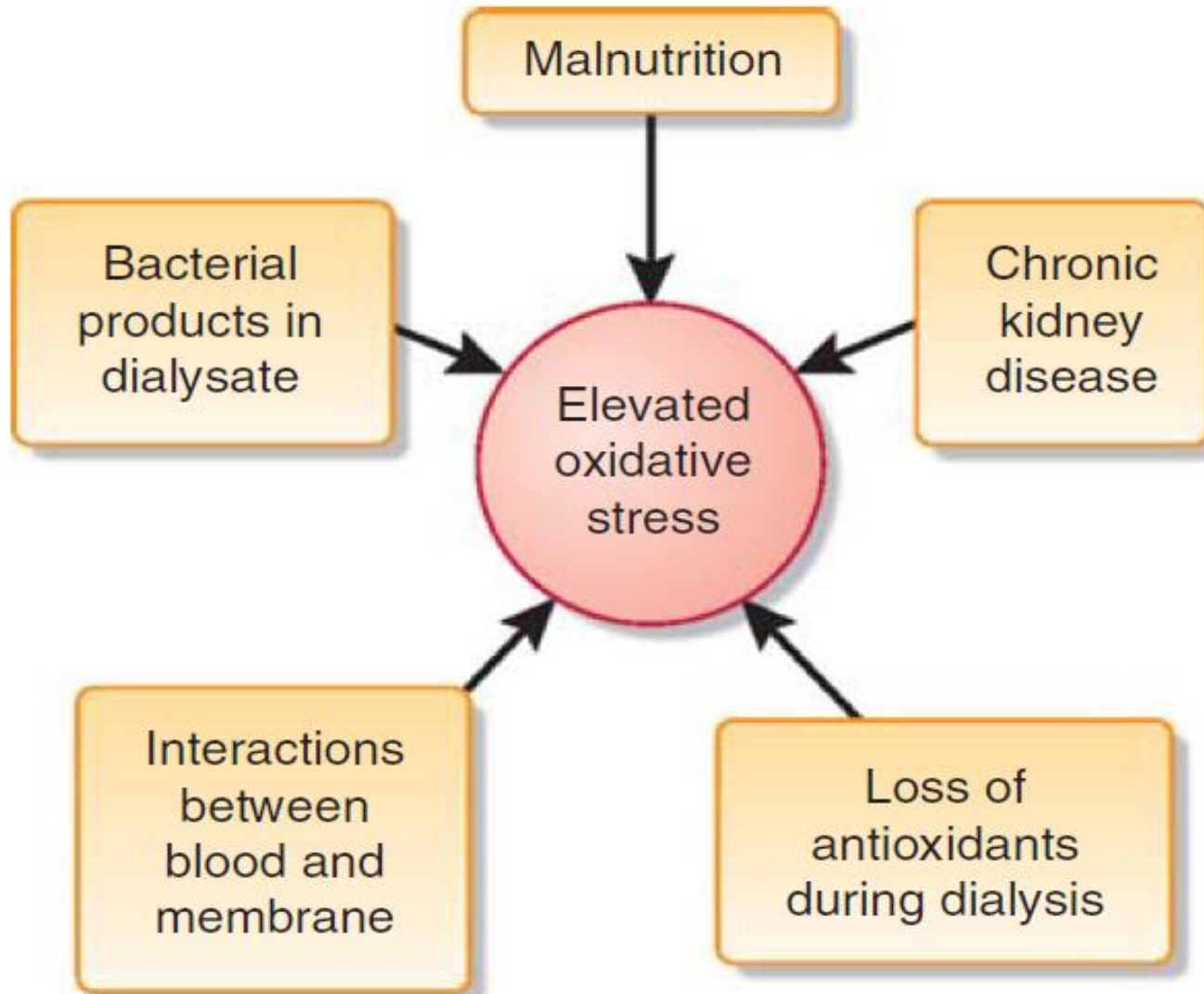
Bio(IN)compatibilità della dialisi



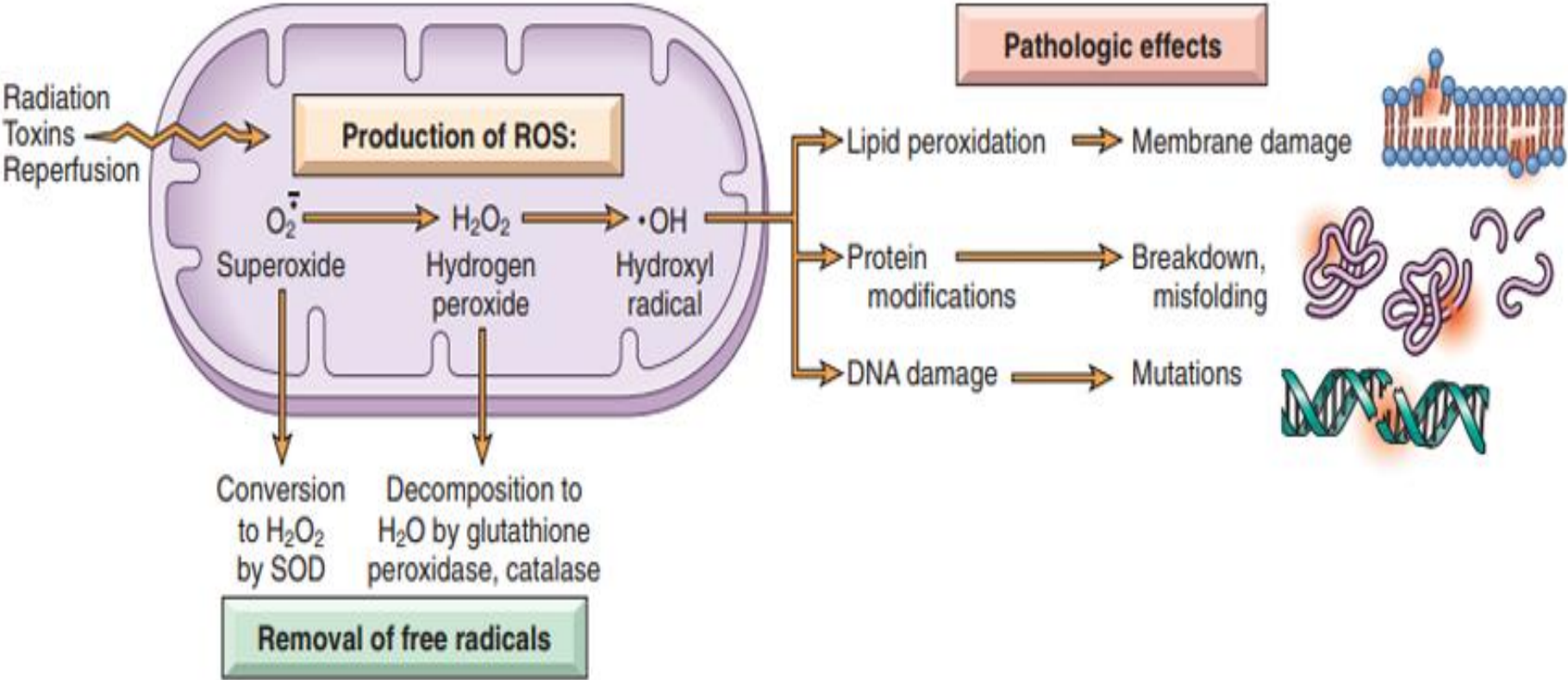
Stress ossidativo in CKD



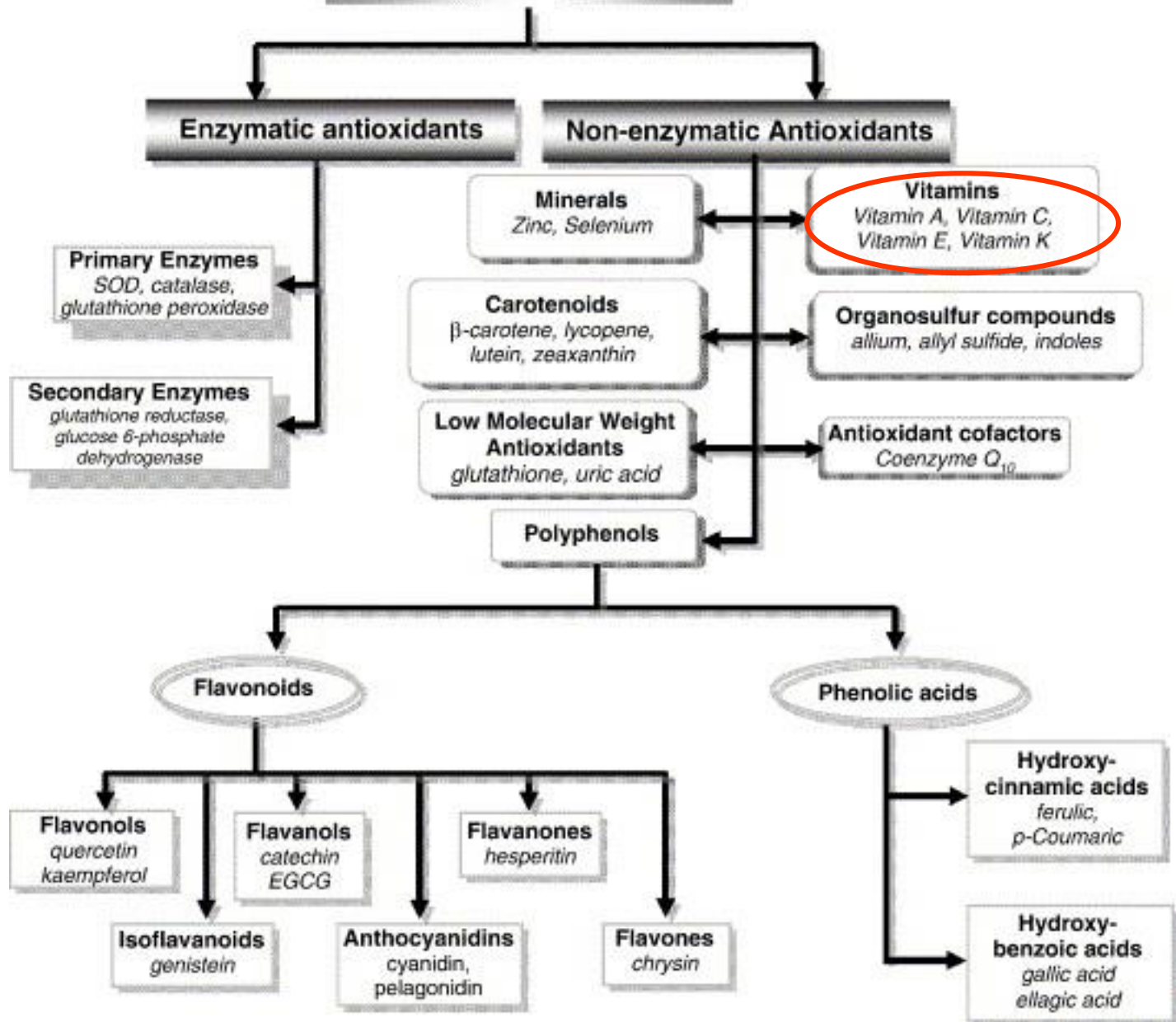
Stress ossidativo in HD



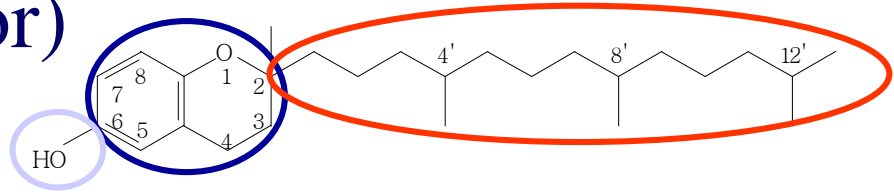
Effetti dei ROS



ANTIOXIDANTS



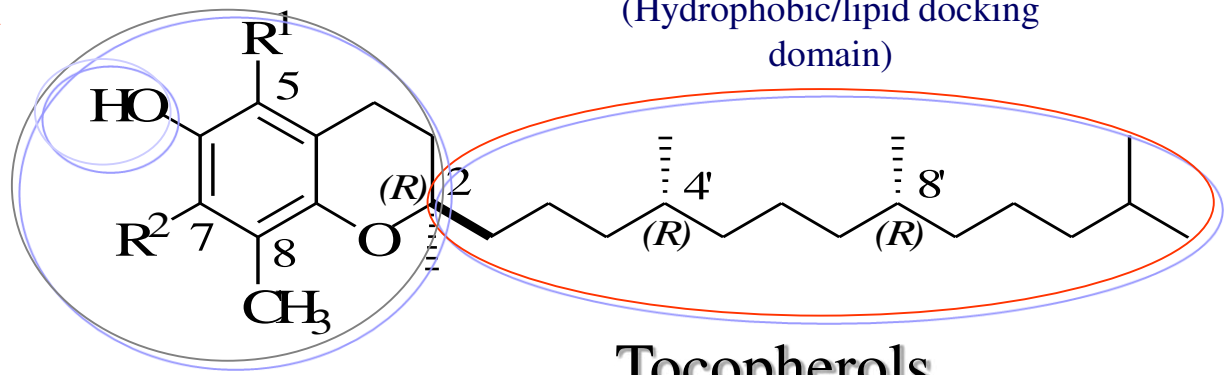
TOCOL (the plant precursor)



Functional domain
(Antioxidant)

Chroman ring

Phytyl chain
(Hydrophobic/lipid docking domain)



Tocopherols

R ¹	R ²	Vitamer
CH ₃	CH ₃	α
CH ₃	H	β
H	CH ₃	γ
H	H	δ

<p>TOCOPHEROLI</p>	R ¹	R ²	
	CH ₃	CH ₃	α-Tocopherol
	CH ₃	H	β-Tocopherol
	H	CH ₃	γ-Tocopherol
	H	H	δ-Tocopherol
<p>TOCOTRIENOLI</p>	R ¹	R ²	
	CH ₃	CH ₃	α-Tocotrienol
	CH ₃	H	β-Tocotrienol
	H	CH ₃	γ-Tocotrienol
	H	H	δ-Tocotrienol

Vitamina E...un po' di storia

Natural foodstuffs contain a substance, X, which prevents such a sterility or which cures the disorder occasioned by the purified dietary regime. We have thus been able to witness a comparatively sudden restoration of fertility to animals of proven sterility, and whose controls continued sterile, by the administration of fresh green leaves of lettuce. Even the dried leaves of alfalfa appear to possess a similar potency. The proven efficacy of leaves invites inquiry into the certainty of segregation of the new dietary factor from vitamins A and C. As regards A, it is conceivable that amounts of A adequate for normal growth, freedom from eye disease and, indeed, vigorous health might still be inadequate for the reproductive function.

We have undertaken a series of experiments designed to trace further in natural foods the distribution of the substance thus shown to be indispensable for the production of healthy young.

ON THE EXISTENCE OF A HITHERTO
UNRECOGNIZED DIETARY FAC-
TOR ESSENTIAL FOR RE-
PRODUCTION¹



Science. 1922 Dec 8;56(1458):650-1.



HERBERT M. EVANS
K. SCOTT BISHOP

Vitamina E...un po' di storia

- **1938** Fernholz provides the structural formula of vitamin E and Nobel laureate Karrer synthesises dl-a-tocopherol



Erhard Fernholz



Paul Karrer

- **1980** McKay and King suggest that vitamin E functions as an antioxidant located primarily in the cell membrane
- **1990** Kaiser and coworkers elucidate the singlet oxygen quenching capability of vitamin E

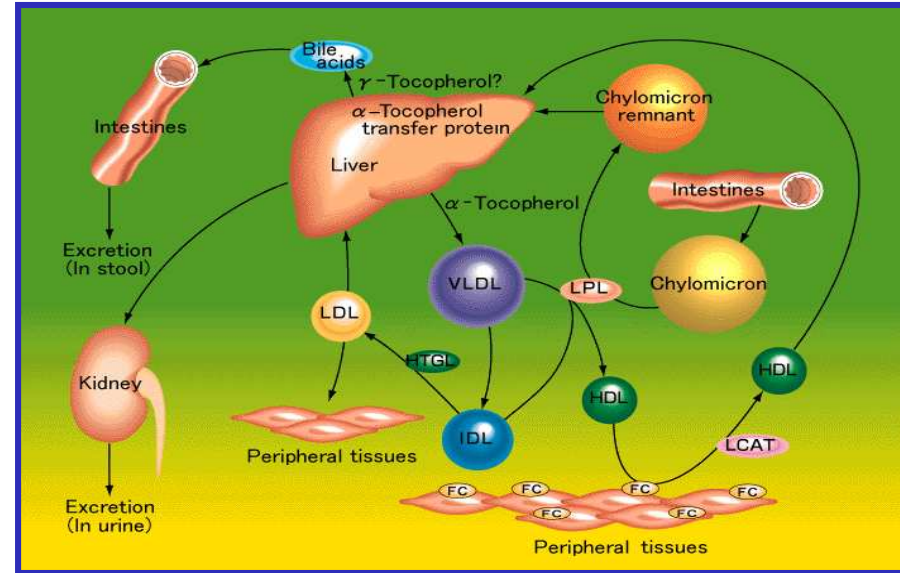
Vitamina E...fonti alimentari



Food	Vitamin E (mg α -TE/100g)
Wheat germ oil	174
Sunflower oil	63
Hazelnut	26
Rape seed oil	23
Soya bean oil	17
Olive oil	12
Peanuts	11
Walnuts	6
Butter	2
Spinach	1.4
Tomatoes	0.8
Apples	0.5
Milk (whole)	0.14

Vitamina E...metabolismo

- La Vitamina E è presente negli alimenti sotto forma di esteri del tocoferolo
- Gli esteri sono idrolizzati da un'estere-idrolasi pancreatica e assorbiti a livello dell'intestino tenue (51-86%) insieme agli acidi grassi liberi e ai monogliceridi
- Successivamente incorporati nei chilomicroni e trasportati al fegato



- L'alfa-Tocoferolo è la forma predominante nel sangue e nei tessuti; ciò è dovuto alla presenza di una proteina epatica (alfa-TTP) che la incorpora all'interno delle lipoproteine, attraverso cui l'alfa-Tocoferolo viene distribuito nei differenti tessuti
- Escreta principalmente attraverso le feci; in minima parte viene escreta con le urine sotto forma di metaboliti idrofili (alfa-CEHC)
- La vitamina E è presente nella maggior parte dei tessuti, ma soprattutto a livello di fegato, muscoli e tessuto adiposo

Vitamina E...carenza

La carenza di Vitamina E è rara!

Solitamente deriva da sindromi da malassorbimento dei grassi

Può comportare **disturbi neuronali, retinopatia**, compromissione della **risposta immunitaria, anemia emolitica e disturbi ossidativi**

Vitamina E...supplementazione orale

Is there any clinical value?



Consensus statement:

Oral supplementation of vitamin E is NOT recommended for the secondary prevention of CVD and cancer (at least in the general population)

Reviewed in:

Galli and Azzi, 2010; Brigelius-Flohe and Galli, 2010; Viola et al., 2011

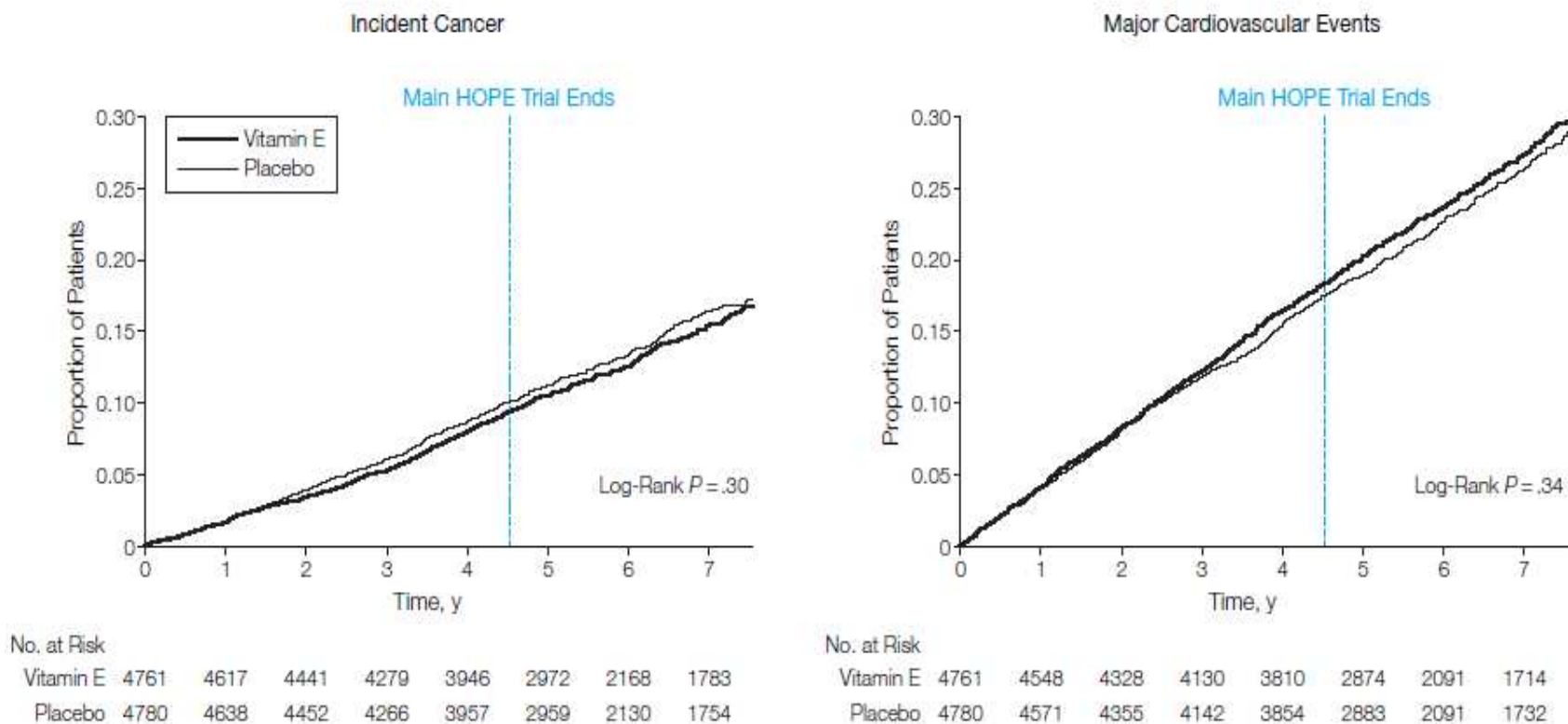
Effects of Long-term Vitamin E Supplementation on Cardiovascular Events and Cancer

A Randomized Controlled Trial

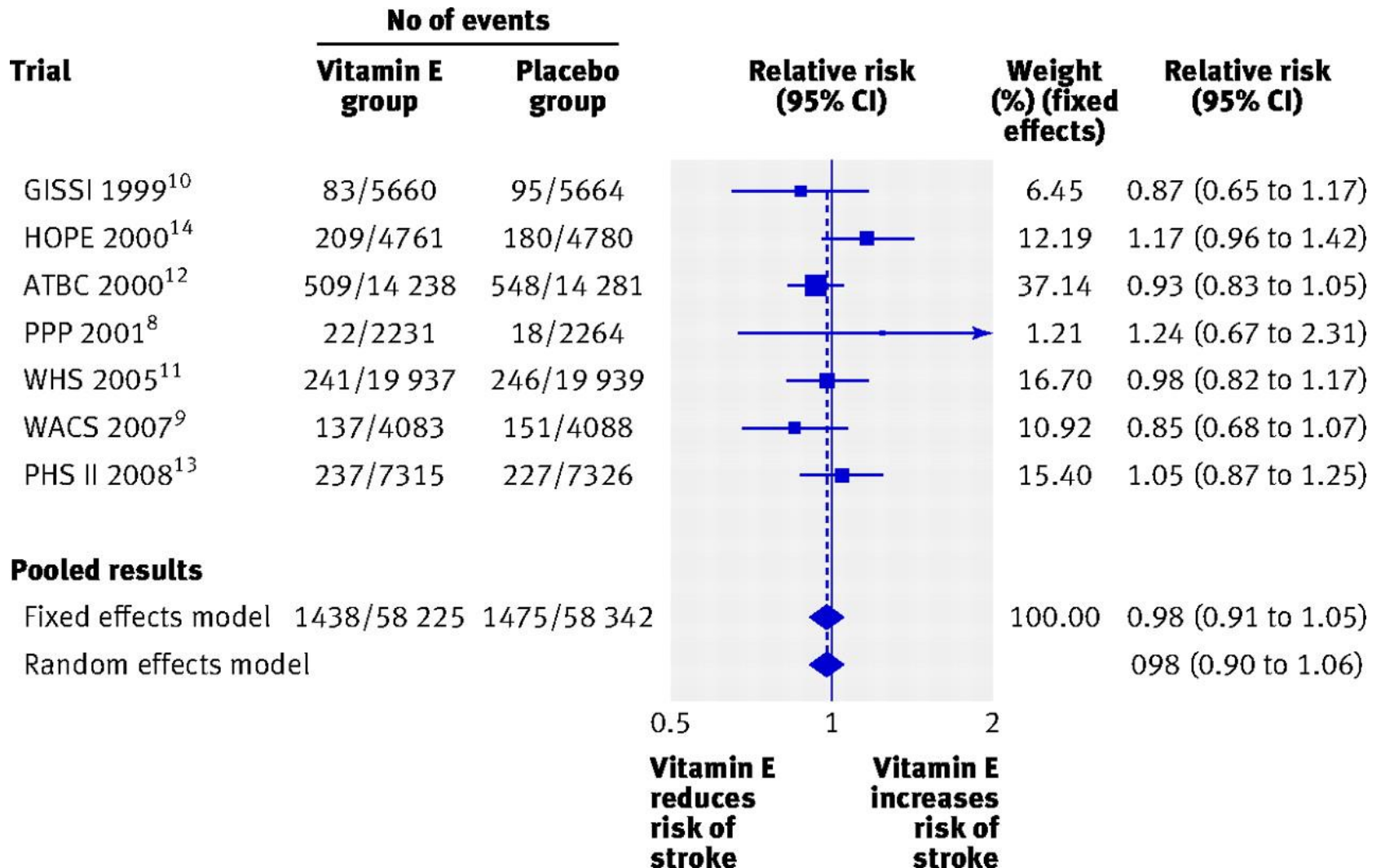
The HOPE and HOPE -TOO Trial

- ✓ Pz ≥ 55 aa, con malattia vascolare o diabete mellito
- ✓ Follow-up fino a 7 anni nell'estensione dello studio
- ✓ Gruppo trattato con Vitamina E 400 UI/die vs gruppo placebo

Figure 2. Kaplan-Meier Analysis of the Effects of Vitamin E on Incident Cancer and Major Cardiovascular Events for All 9541 Study Patients



Meta-analisi studi clinici su popolazione generale: Vitamina E e rischio di stroke



Vitamina E...supplementazione orale



Is this always true?

This could not be true in sub-groups of patients showing severe oxidative stress, symptoms of suboptimal intake or deficiency of Vitamin E, such as:

- **Uremia and dialysis**
- Cystic fibrosis
- Muscular dystrophy and other degenerative forms of the muscle and bone
- Ataxia and other genetic or acquired neuromuscular syndromes

Vitamin E in Uremia and Dialysis Patients

FRANCESCO GALLI, UMBERTO BUONCRISTIANI, CARMELA CONTE,
CRISTINA AISA, AND ARDESIO FLORIDI 2004

TABLE 1. Plasma levels of lipids, vitamin E, and CEHC metabolites in 111 healthy control subjects and 104 ESRD patients on regular hemodialysis

	Healthy Controls	HD Patients	Statistics ^a
Total cholesterol (mmol/L)	5.38 ± 0.61	6.16 ± 1.55	<i>P</i> < 0.05
Triglycerides (mmol/L)	1.22 ± 0.39	2.71 ± 1.19	<i>P</i> < 0.01
α-Tocopherol (mmol/L)	28.4 ± 3.5	28.9 ± 6.7	NS
γ-Tocopherol (mmol/L)	2.44 ± 0.36	1.38 ± 0.49	<i>P</i> < 0.01
	(<i>n</i> = 28)	(<i>n</i> = 39)	
α-Tocopherol (mmol/mmol TL)	4.30 ± 0.52	3.26 ± 0.75	<i>P</i> < 0.01
γ-Tocopherol (mmol/mmol TL)	0.37 ± 0.05	0.16 ± 0.06	<i>P</i> < 0.01
	(<i>n</i> = 2)	(<i>n</i> = 39)	
α-CEHC (nmol/L)	16.8 ± 7.5	79.2 ± 28.3	<i>P</i> < 0.01
	(<i>n</i> = 10)	(<i>n</i> = 14)	
γ-CEHC (nmol/L)	190.7 ± 61.0	688.6 ± 180.3	<i>P</i> < 0.01
	(<i>n</i> = 10)	(<i>n</i> = 14)	



Vitamin E therapy in HD patients

***ORAL
SUPPLEMENTATION***

***VITAMIN E-coated
MEMBRANE***



Vitamin E therapy in HD patients: oral supplementation

Secondary prevention with antioxidants of cardiovascular disease in endstage renal disease (SPACE): randomised placebo-controlled trial

THE LANCET

Boaz M et al., 2000

Study design: pts in HD with previous history of CVD

97 pts \Rightarrow 800 UI/day vitamin E

99 pts \Rightarrow placebo

Follow-up 519 days (1 year and 5 months)

Parameters:

Primary endpoints: composite variable including fatal and non-fatal MI, ischaemic stroke, peripheral vascular disease, unstable angina

Secondary outcomes: including total and CVD mortality

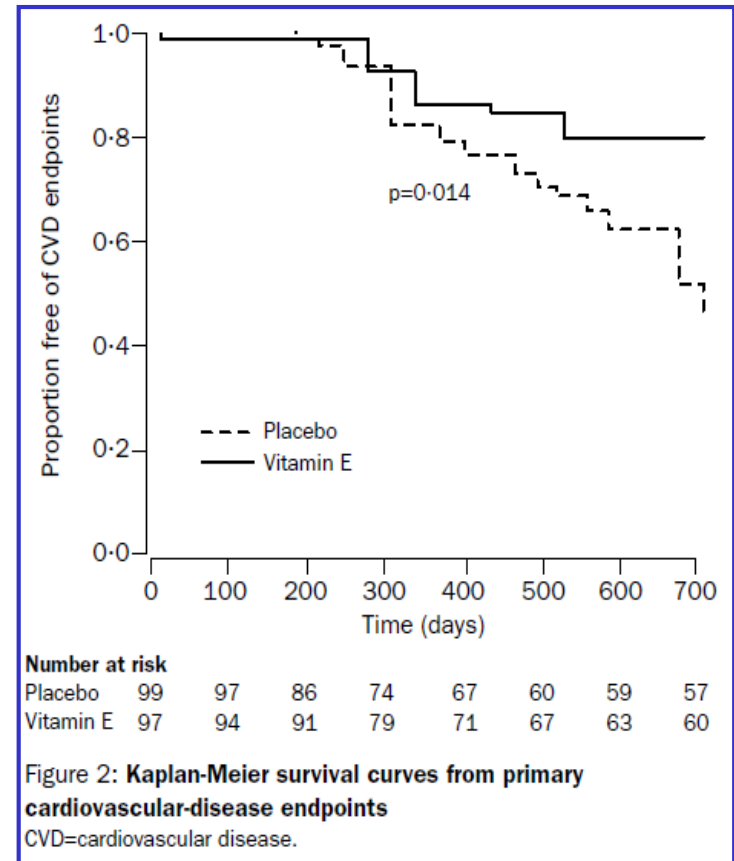
Significant results:

Vitamin E group \Rightarrow 15 primary endpoints (5 MI)

Placebo group \Rightarrow 33 primary endpoints (17 MI)

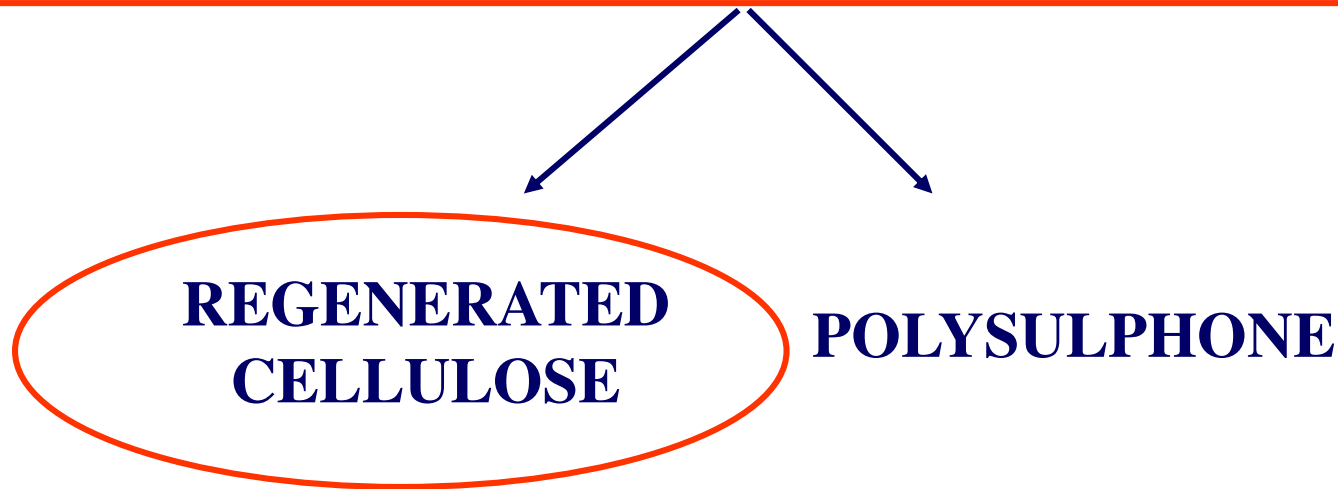
(54% reduction in primary endpoints and 70% in MI,

$p= 0.014$ and 0.016 respectively, in vit E treated group)



Vitamin E therapy in HD patients

- **ORAL SUPPLEMENTATION**
- **VITAMIN E-coated MEMBRANE (VECM)**



A systematic review of the effect of the Excebrane dialyser on biomarkers of lipid peroxidation

MDA/TBARS

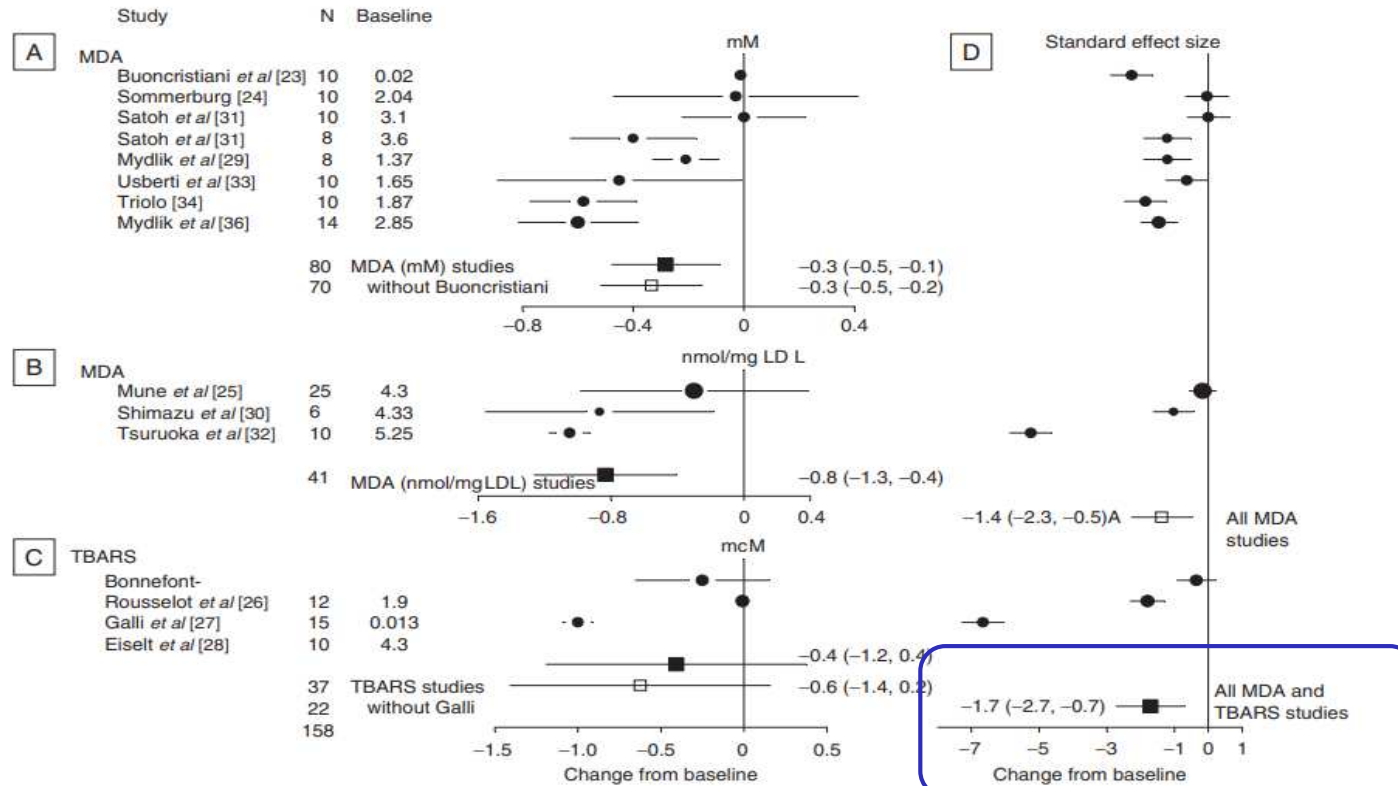


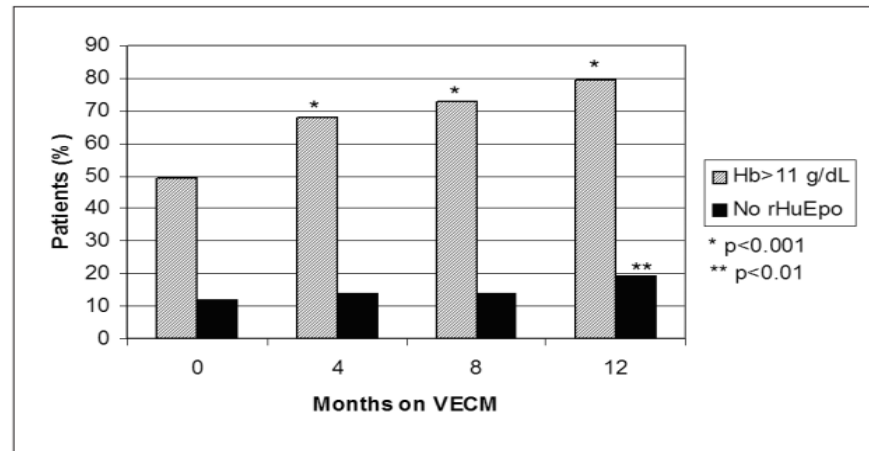
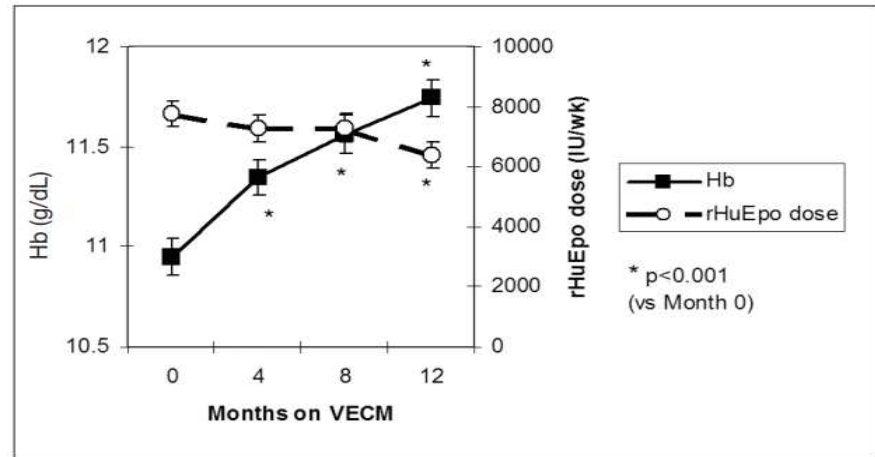
Fig. 1. Effect of the Excebrane dialyser on pre-dialysis malondialdehyde (MDA) and Thiobarbituric Acid Reactive Substances (TBARS) levels. The meta-analysis was performed using the random effects model. (A) and (B) display changes in pre-dialysis mean MDA levels from baseline, for studies where this biomarker was reported in mM and nmol/mg LDL, respectively. (C) displays changes in pre-dialysis mean TBARS levels (μM) from baseline. (D) displays changes in pre-dialysis lipid peroxidation biomarker levels from baseline, using the standardized effect size. All the data are presented as mean changes with 95% CI.

THE CONVERSION OF DIALYSIS PATIENTS TO A VITAMIN-E COATED DIALYSER IS ASSOCIATED WITH AN IMPROVEMENT IN CIRCULATING BIOMARKERS OF LIPID PEROXIDATION, WHICH IS OF POTENTIAL CLINICAL BENEFIT

Effect of vitamin E-coated dialysis membranes on anemia in patients with chronic kidney disease: An Italian multicenter study

D.N. CRUZ^{1,2}, M. DE CAL¹, F. GARZOTTO¹, A. BRENDOLAN¹, F. NALESSO¹, V. CORRADI¹, C. RONCO¹

- Open-label multicenter study
- 172 stable chronic HD patients were shifted from their previous dialyzer to VECM for 1 year
- Outcome measures:
 - Hb
 - Weekly rHuEPO dose
- Measured at:
 - Baseline (Month 0)
 - Month 4
 - Month 6
 - Month 12



Effects of vitamin E-coated membrane dialyser on markers of oxidative stress and inflammation in patients on chronic haemodialysis

Dimitrios Kirmizis, Aikaterini Papagianni, Anna-Maria Belechri and Dimitrios Memmos

Table 5. Comparison of 6-month changes in the parameters studied between VEM group and controls **35 patients, 6 months controlled trial**

Parameter	Controls	VEM	Δ	Comparison 95% CI	P-value
Total cholesterol, mg/dL	4 ± 62	21 ± 38	17	-13 to 47	0.27
HDL cholesterol, mg/dL	4 ± 6	5 ± 4	1	-2 to 5	0.26
LDL cholesterol, mg/dL	2 ± 52	10 ± 29	8	-19 to 36	0.54
Triglycerides, mg/dL	-1 ± 81	20 ± 86	21	-33 to 74	0.44
ApoA1, g/L	3 ± 31	6 ± 24	3	-14 to 20	0.75
ApoB, g/L	5 ± 37	-2 ± 32	-7	-29 to 14	0.50
Apo B/A1	-0.04 ± 0.5	-0.03 ± 0.3	-0.07	-0.23 to 0.24	0.95
Lp(a), μmol/L	1.6 ± 3.4	0.3 ± 3.5	-1.3	-3.5 to 0.9	0.24
Albumin, g/L	0.1 ± 0.4	0.1 ± 0.5	0	-35 to 13	0.17
Urate, mg/dL	-0.3 ± 0.8	0.04 ± 1.0	-0.26	-0.2 to 1.0	0.24
White blood count, × 10 ⁹ /L	400 ± 1300	-30 ± 1300	-430	-1300 to 390	0.29
CRP, mg/L	0.9 ± 3.5	-2.6 ± 3.2 *	-3.5	-5.4 to -1.6	0.001
hsIL-6, pg/mL	-0.7 ± 3.4	-2.6 ± 4.6 *	-3.3	-4.1 to 0.3	0.07
sICAM-1, ng/mL	9 ± 132	-58 ± 73 *	-67	-129 to -5	0.03
sVCAM-1, ng/mL	85 ± 382	-166 ± 1626	-251	-864 to 362	0.41
E-selectin, ng/mL	-2 ± 48	-12 ± 34	-10	-31 to 12	0.38
MCP-1, ng/mL	-6 ± 38	3 ± 58	9	-30 to 49	0.63
oxLDL, U/L	-2 ± 19	-12 ± 10 *	-10	-19 to -1	0.04
TAS, mmol/L	-0.01 ± 0.1	0.1 ± 0.2 *	0.11	-0.01 to 0.2	0.06
TBARS, nmol/L	-0.7 ± 1.9	-1.3 ± 2.9 *	-0.6	-2.5 to 1.3	0.53
Fas, pg/mL	-236 ± 4129	-1171 ± 6146	-935	-4271 to 2400	0.57
FasL, pg/mL	10 ± 25	4 ± 27	-6	-21 to 10	0.46

Results are expressed as mean ± SD. Comparison of mean differences (with 95% confidence intervals of the difference) for each variable was estimated using Student's *t*-test: positive numbers for TAS and negative numbers for all other variables favour VEM.

Vitamin E therapy in HD patients

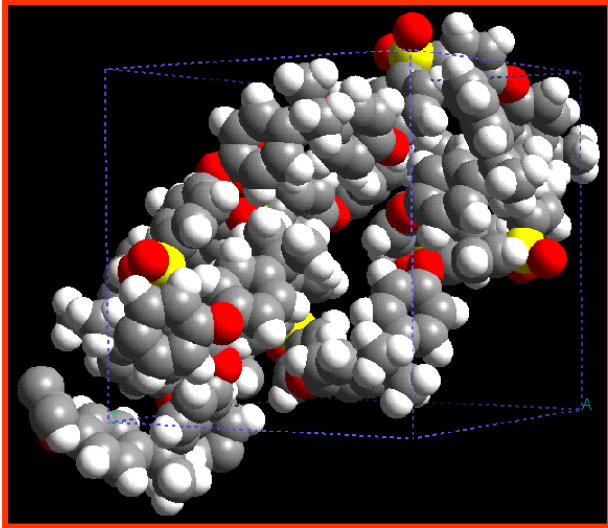
- **ORAL SUPPLEMENTATION**
- **VITAMIN E-bonded hemodialysers**

**REGENERATED
CELLULOSE**

POLYSULPHONE

```
graph TD; A[Vitamin E therapy in HD patients] --> B[ORAL SUPPLEMENTATION]; A --> C[VITAMIN E-bonded hemodialysers]; C --> D[REGENERATED CELLULOSE]; C --> E[POLYSULPHONE];
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VITAMIN E-bonded polysulphone

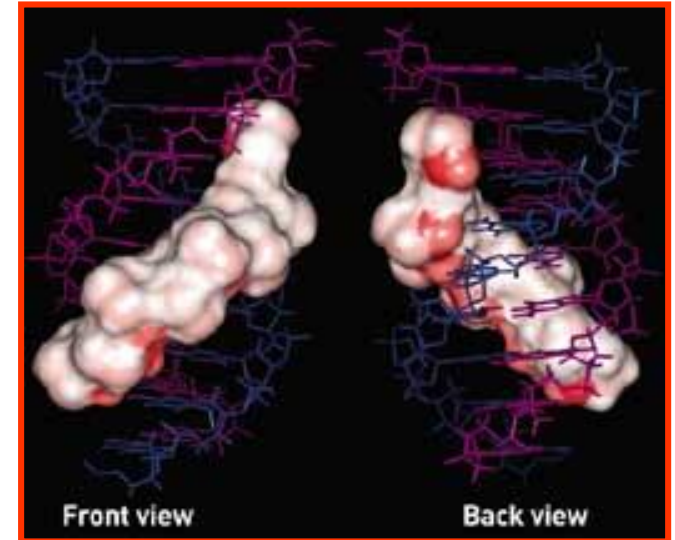


Polysulphone

- High mechanical and termic resistance
- Hydrophobic

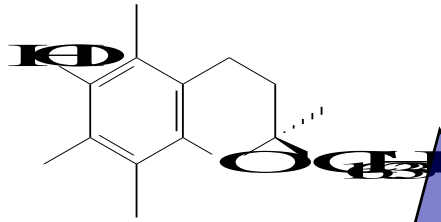
PVP

- Vinilic polymer
- Hydrophilic

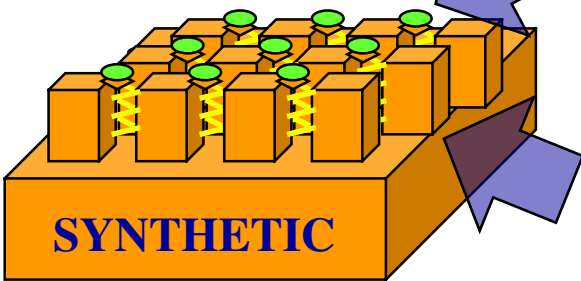


Totally Sinthetic membrane

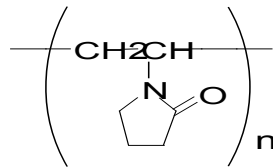
VITAMIN E-bonded polysulphone



Bio-active surface molecule



Hydrophilic zone

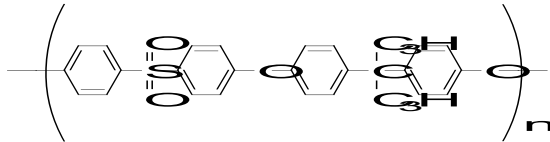


Alfa-tocopherol
Covalent binding at the membrane surface

PVP (Hydrophilic)
Present in microdomains

Polysulfone (Hydrophobic)
Major constituent of the membrane

Hydrophobic zone

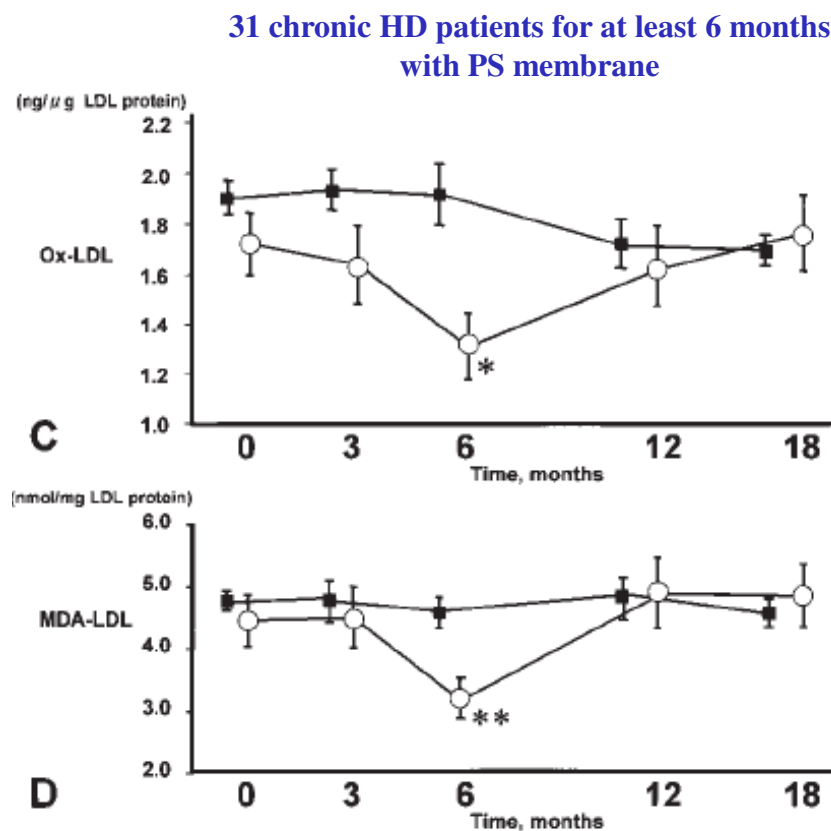
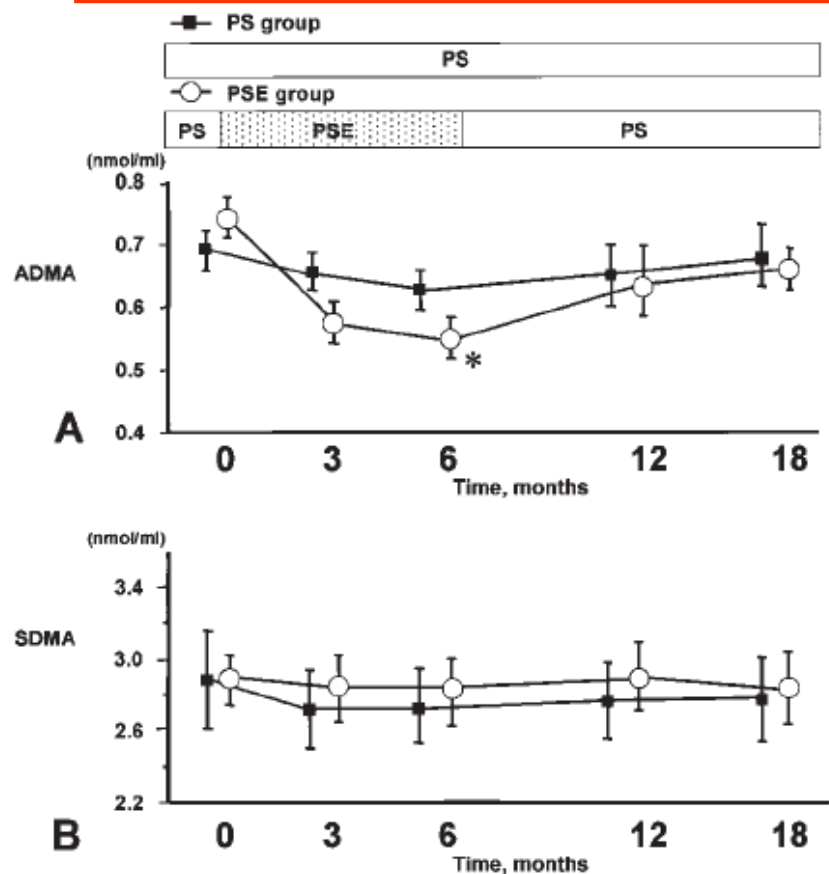


Totally synthetic membrane binding Vitamin E

Original Article

Long-term use of vitamin E-coated polysulfone membrane reduces oxidative stress markers in haemodialysis patients

Hisanori Morimoto, Kazushi Nakao, Kousuke Fukuoka, Ai Sarai, Ai Yano, Takashi Kihara, Shinji Fukuda, Jun Wada and Hirofumi Makino

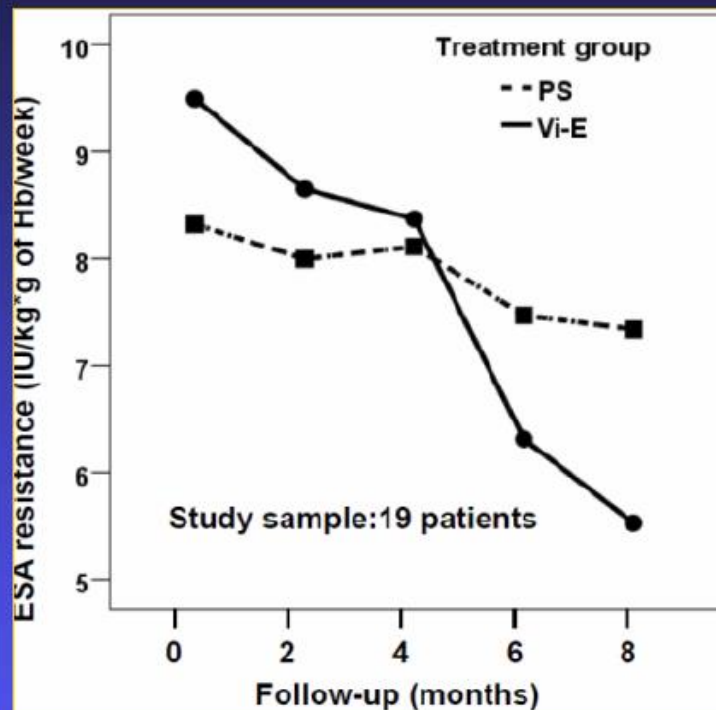


controlled randomized pilot trial

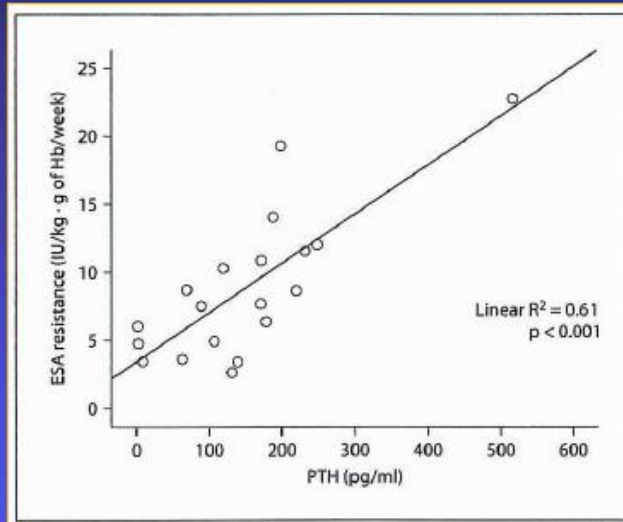
Effect of Synthetic Vitamin E-Bonded Membrane on Responsiveness to Erythropoiesis-Stimulating Agents in Hemodialysis Patients: A Pilot Study

Simeone Andrulli^a Salvatore Di Filippo^a Celestina Manzoni^a Luca Stefanelli^b
Alessandro Floridi^b Francesco Galli^b Francesco Locatelli^a

^aDepartment of Nephrology, Dialysis and Renal Transplantation, A. Manzoni Hospital, Lecco, and
^bDepartment of Internal Medicine, University of Perugia, Perugia, Italy



Effect	P value
Follow-up	0.311
Treatment	0.042
After adjustment for:	
Intact PTH	0.007
γ tocopherol	0.028
α tocopherol	0.022



- Beneficial effect on ESA resistance
- Relevance of baseline PTH and Vitamin E levels in predicting ESA resistance

A Vitamin E-Coated Polysulfone Membrane Reduces Serum Levels of Inflammatory Markers and Resistance to Erythropoietin-Stimulating Agents in Hemodialysis Patients: Results of a Randomized Cross-Over Multicenter Trial

Vincenzo Panichi^a Alberto Rosati^b Sabrina Paoletti^a Paolo Ferrandello^a
Massimiliano Migliori^a Sara Beati^a Giada Bernabini^a Roberto Daini^c Aldo Casani^c
Daniela Angelini^b Manuela Parrini^b Arturo Rossi^d Isabella Petrone^d Giuliano Barsotti^e
Carlo Donadio^e Giacli Donati^f Giovanni Grazi^f Giovanni Manca Rizza^f Guido Garosi^g
Enrico Sansoni^g Beatrice Braccagni^g Antonino Sidoti^h Donella Boracelli^h Marina Biagioli^h
Luigi Moriconiⁱ Viviana Finatoⁱ Antonio Mannarino^j Cristina Grimaldi^j Filomena Pansa^k
Patrizio Imperiali^k Carlo Mura^k Stefano Bianchi^k Roberto Bigazzi^l

Departments of Nephrology and Dialysis, ^aHospital of Versilia, Versilia, ^bHospital of Lucca, Lucca, ^cHospital of Massa, Massa, ^dHospital of Pistoia, Pistoia, ^eUniversity of Pisa, Pisa, ^fHospital of Pontedera, Pontedera, ^gHospital of Siena, Siena, ^hHospital of Poggibonsi, Poggibonsi, ⁱHospital of San Miniato, San Miniato, ^jHospital of Florence, Florence, ^kHospital of Arezzo, Arezzo, and ^lHospital of Livorno, Livorno, Italy

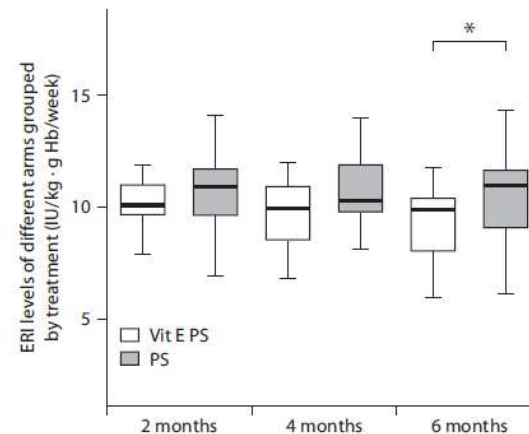
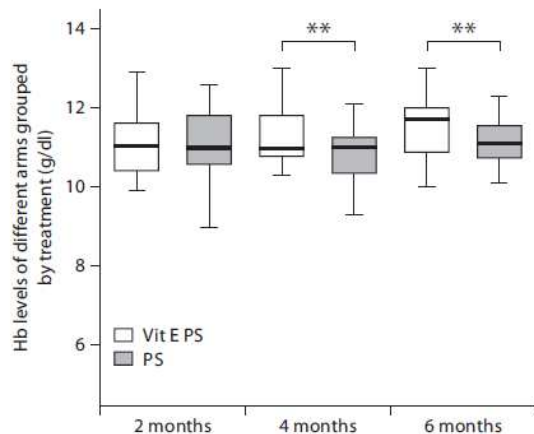
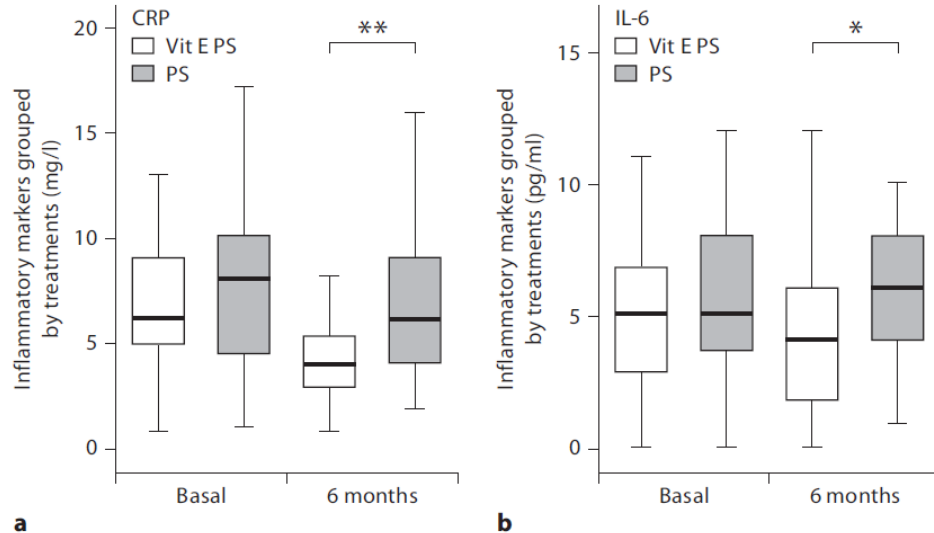
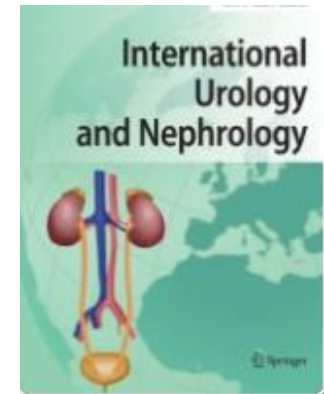


Fig. 2. Hb levels (medians, interquartile ranges and outliers) of different arms grouped by treatment. Hb levels were significantly different at 4 and 6 months. ** $p < 0.001$ baseline vs. 4 and 6 months.

Fig. 3. ERI levels (medians, interquartile ranges and outliers) of different arms grouped by treatment. ERI levels were significantly different at 6 months. * $p < 0.05$ baseline vs. 6 months.

62 patients were randomized (A-B or B-A) in a cross-over design to Vit E PS (treatment A) and to PS (treatment B) both for 6 months.

Treatment with Vit E PS membranes seems to lead to a reduction in ESA dosage in HD patients; in addition, a low chronic inflammatory response may contribute to a sparing effect on exogenous ESA requirements.



Evaluation of the impact of a new synthetic vitamin E-bonded membrane on anemia and rHuEPO requirement in ESRD patients with central venous catheters: a pilot study

S. Mandolfo · B. Corradi · R. Bucci · M. Farina · F. Pilolli · F. Galli

Study design

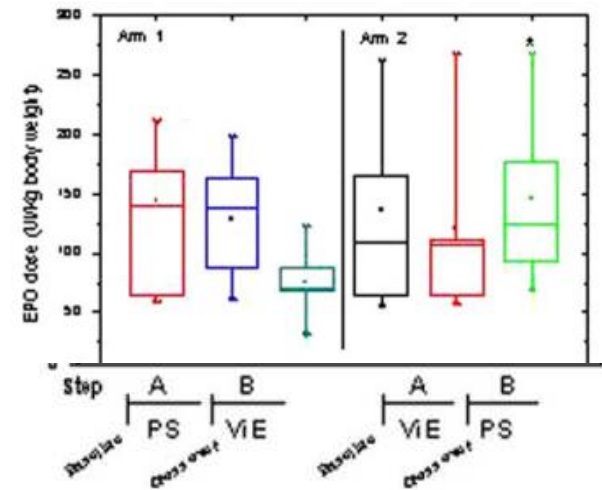
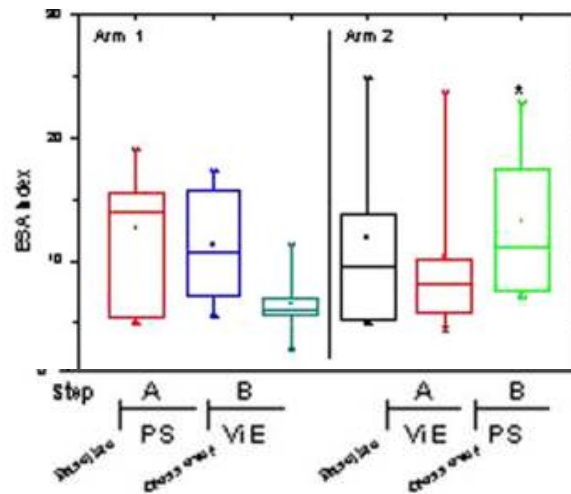
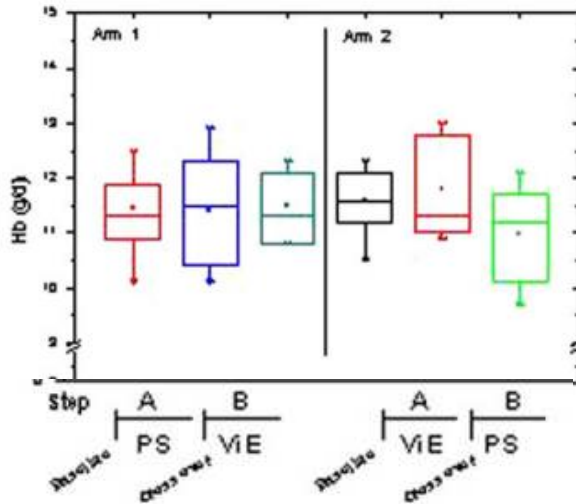


Conclusion

“Vitamin E-modified HD membrane is associated with a reduction in ESA index and rHuEPO requirement in HD patients with CVCs. This effect has already been reported by other studies in HD patients with AVFs.

Although we cannot explain, on the basis of available data, how does this effect occur, clinical data strongly suggest a possible role of Vitabrane in improving the control of anti-anemic therapy over the RBC lifespan”.

Results

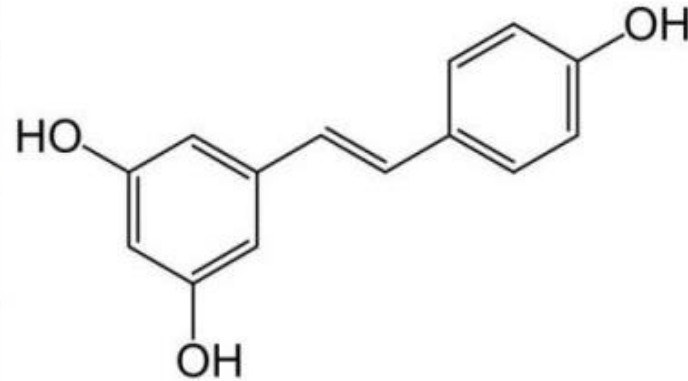


VECM: quali vantaggi?

- **Aumentata biocompatibilità**
- **Minore attivazione delle cellule dell'immunità e delle piastrine**
- **Riduzione dell'infiammazione e dello stress ossidativo**
- **Minore distruzione dei globuli rossi**

**MIGLIORAMENTO DELL'ANEMIA,
DELLA QUALITA' COMPLESSIVA DEL TRATTAMENTO
E DELLA COMPLIANCE DEL PAZIENTE**

Resveratrolo...una nuova arma?



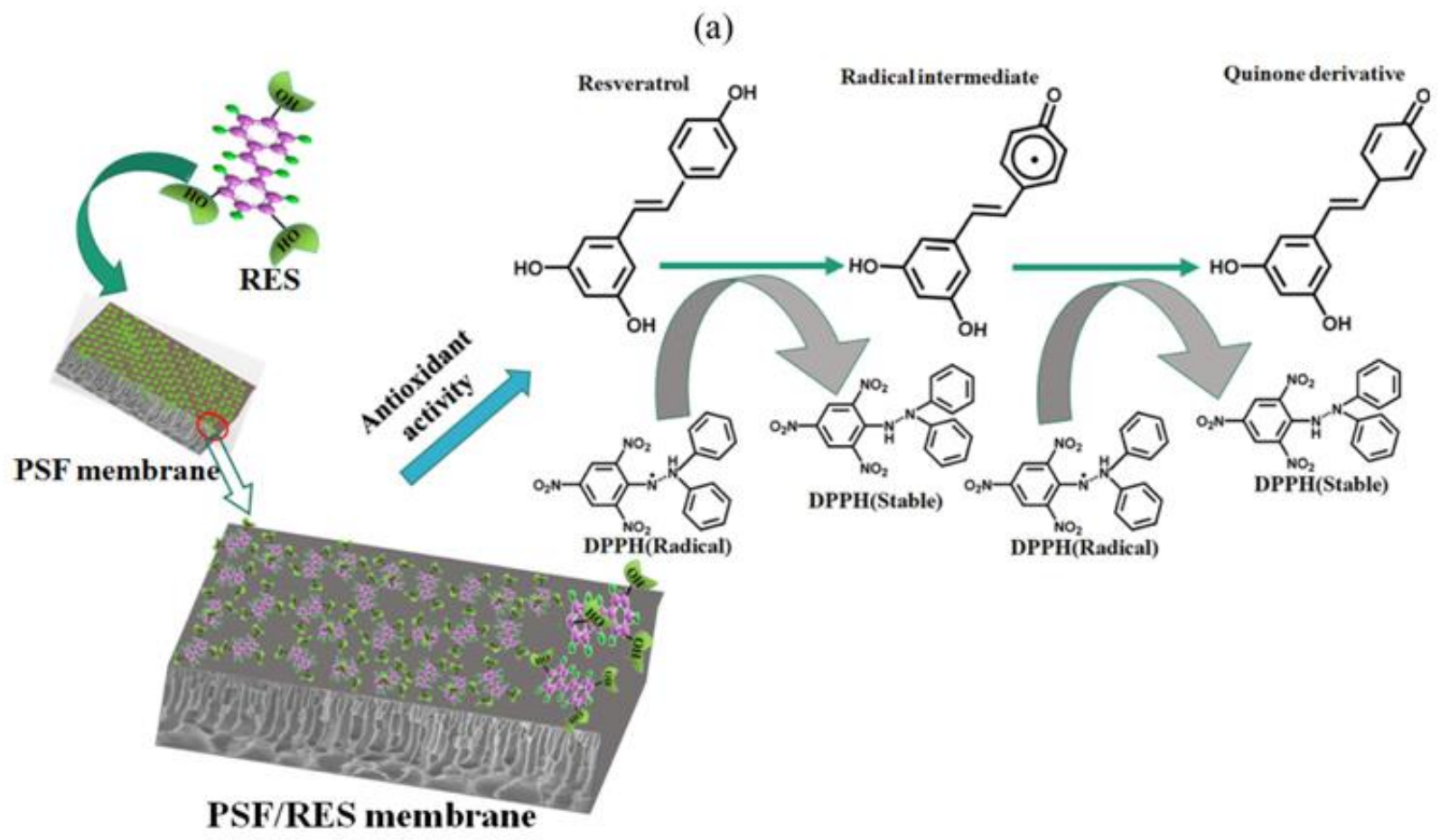
- ✓ Derivato fenolico non flavonoide
- ✓ Estratto in natura da diverse piante (vite, mirtillo, gelso, gelso, arachidi...)
- ✓ Proprietà anti-infiammatorie e anti-ossidanti

Resveratrol as a plant type antioxidant modifier for polysulfone membranes to improve hemodialysis-induced oxidative stress

Xuchao Qi^{a,1}, Ning Yang^{a,*}, Ying Luo^{a,b}, Xuemeng Jia^a, Junqiang Zhao^a, Xia Feng^a, Li Chen^{a,*}, Yiping Zhao^a



2021

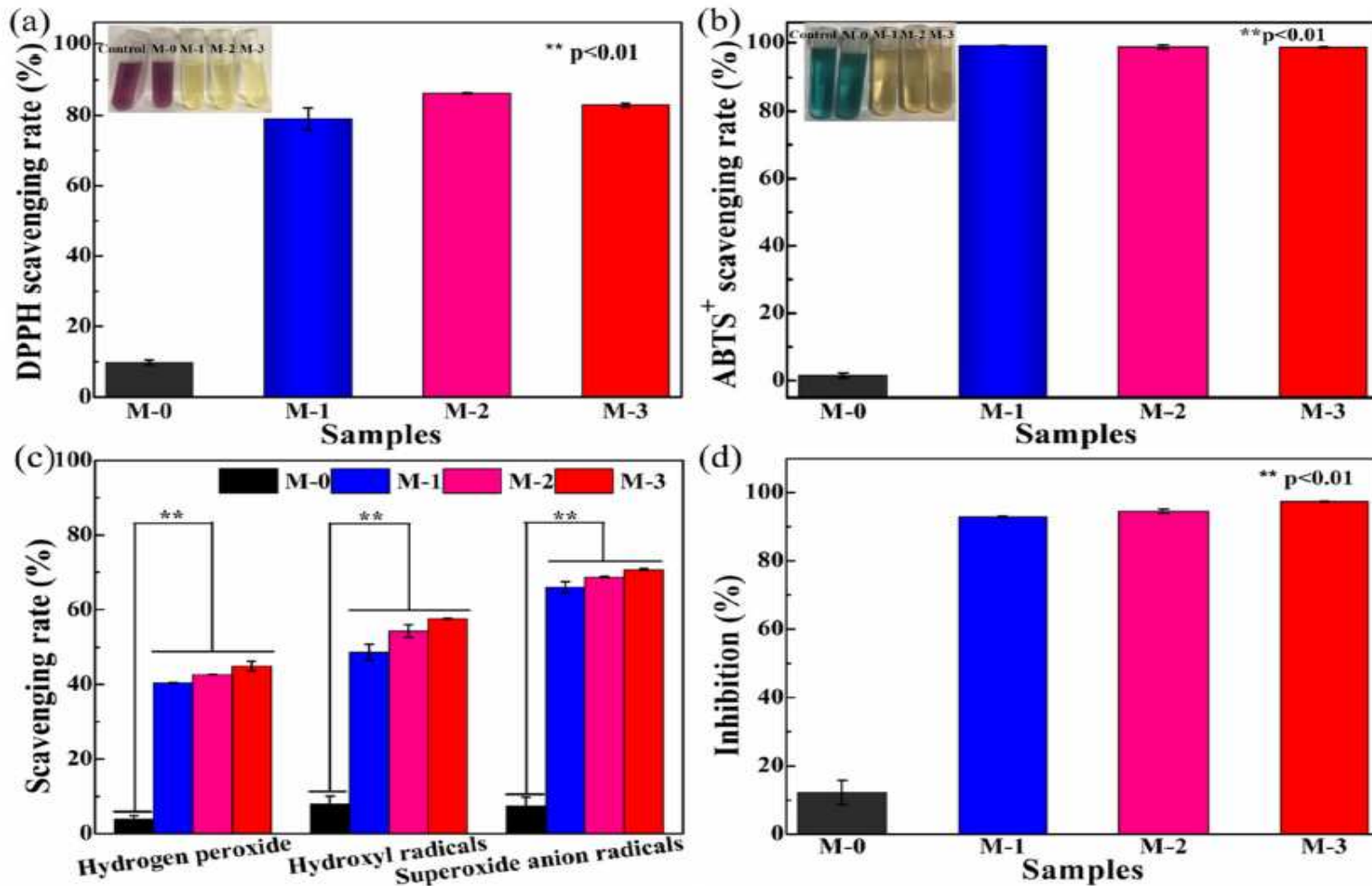


Resveratrol as a plant type antioxidant modifier for polysulfone membranes to improve hemodialysis-induced oxidative stress

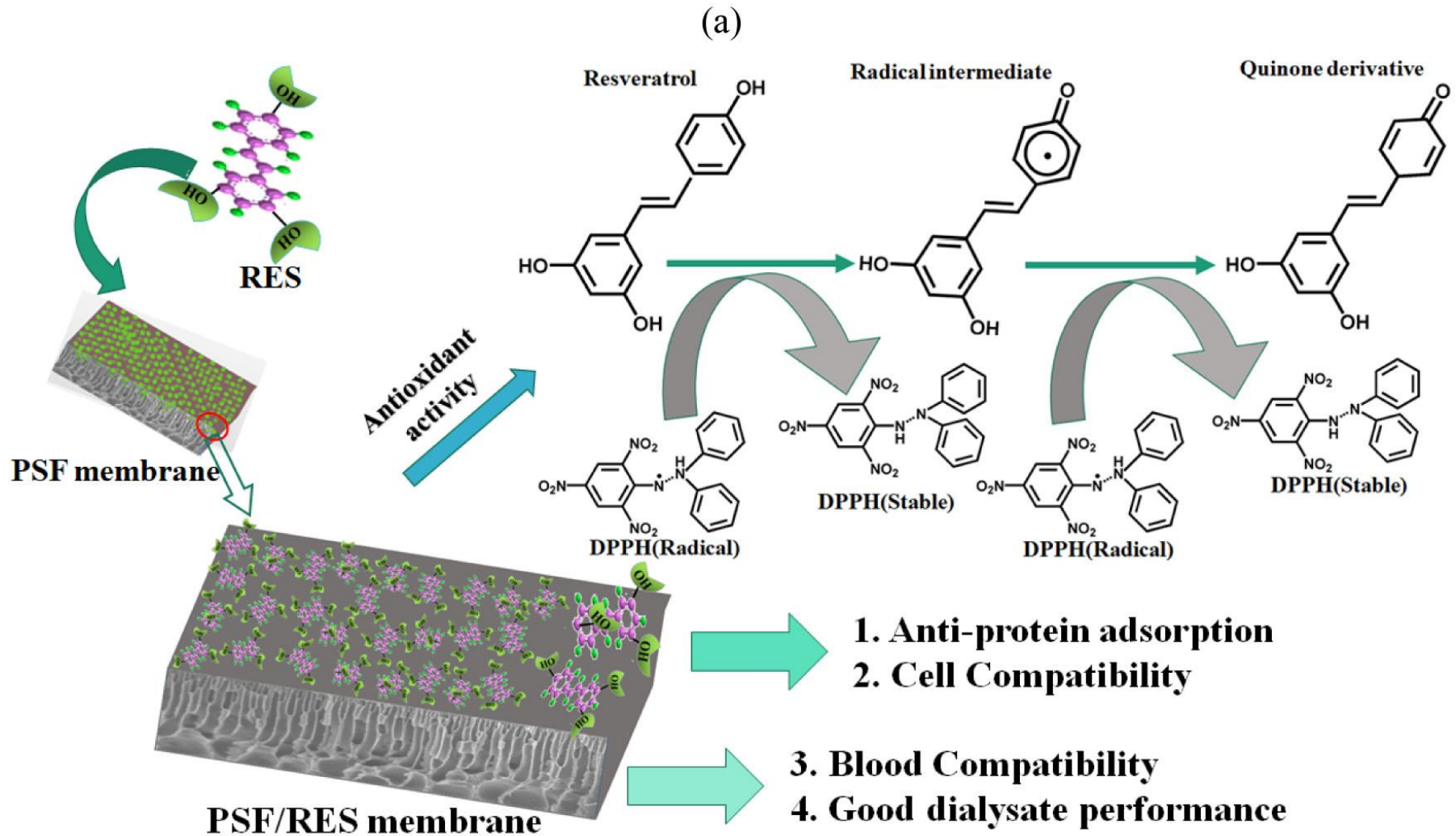
Xuchao Qi^{a,1}, Ning Yang^{a,*,1}, Ying Luo^{a,b}, Xuemeng Jia^a, Junqiang Zhao^a, Xia Feng^a, Li Chen^{a,*}, Yiping Zhao^a



2021

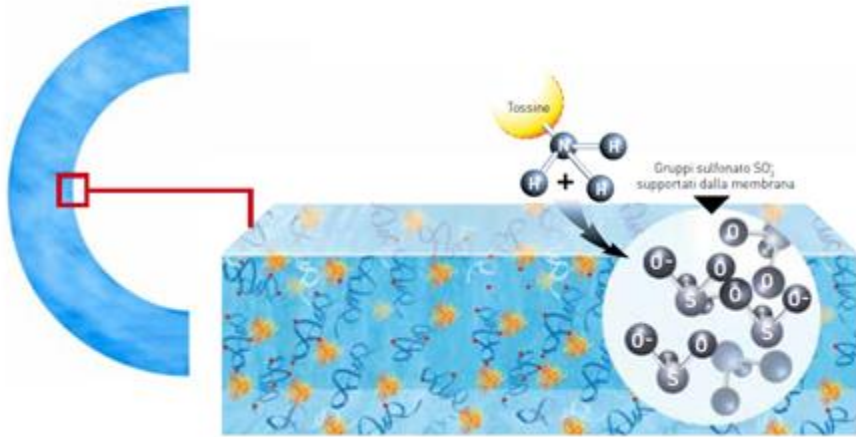


PSF/RES membrane...una nuova arma?



Dalla membrana AN69 alla membrana HeprAN

Membrana con
struttura a idrogel



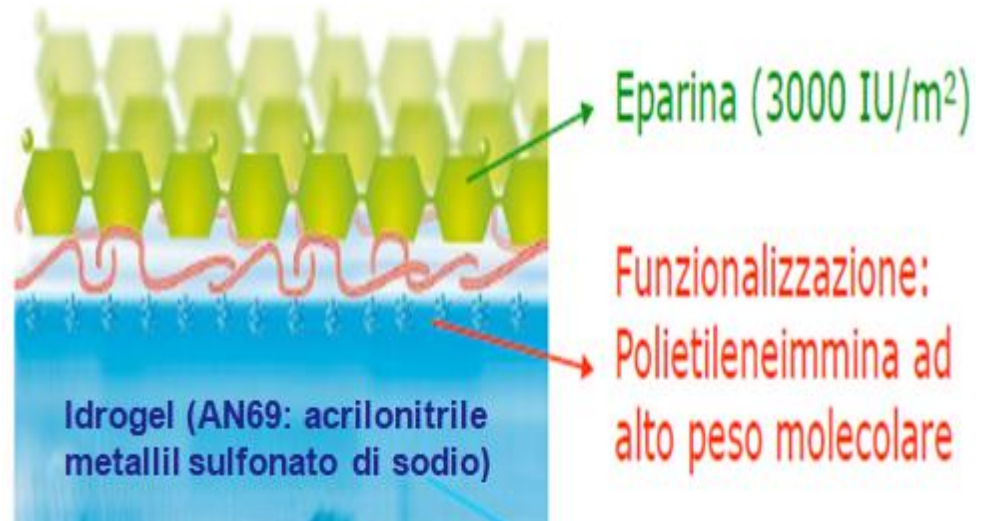
La membrana AN69 è costituita da un copolimero di acrilonitrile-metallil sulfonato di sodio (gruppi sulfonato anionici), caratterizzato da una struttura ad idrogel simmetrica ed omogenea.

Elevate proprietà adsorbenti nei confronti di anafilotossine (frazioni attivate del complemento), citochine (IL1, IL6, TNF) e medie molecole ($\beta 2M$).

Non induce leucopenia intradialitica né piastrinopenia.

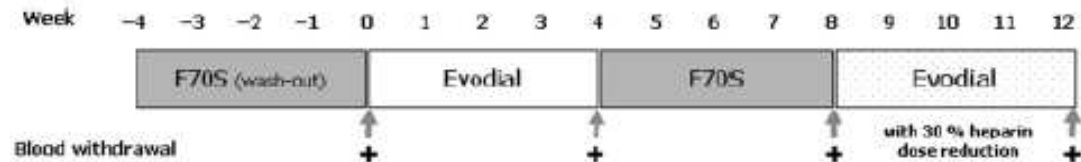
La membrana AN69 trattata in Superficie (AN69ST) è in grado di "catturare" l'eparina durante la fase di priming, migliorando così l'emocompatibilità dell'AN69.

Successivamente l'eparina viene graffata mediante un processo di "funzionalizzazione ionica multipuntuale" che consente di legare in modo irreversibile l'eparina alla membrana, offrendo la possibilità di ridurre o eliminare la somministrazione di eparina durante il trattamento.



Biocompatibility of heparin-grafted hemodialysis membranes: impact on MCP-1 circulating level and oxidative status

Methodology/Design:



A prospective observational study aimed at evaluating the efficacy and biocompatibility performances of the Evodial Dialysers with and without systematic heparin reduction

Participants:

6 HD patients enrolled, each patient being their own control

Intervention:

First blood sampling performed at baseline, after 4, 8 and 12 weeks of treatment from baseline (dialysis conditions remained unchanged for each patient)

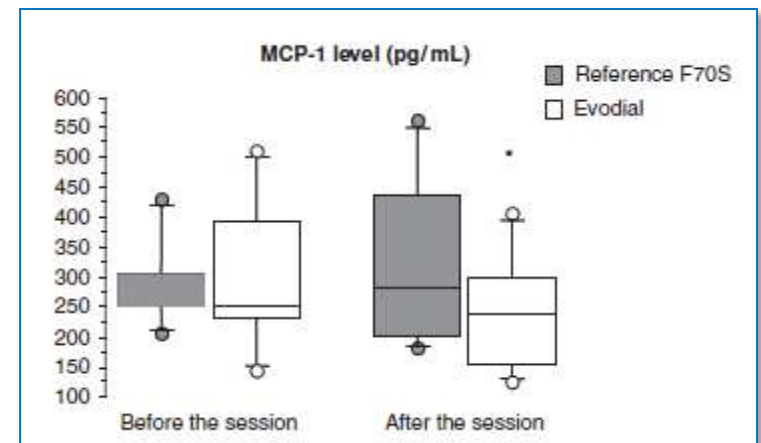
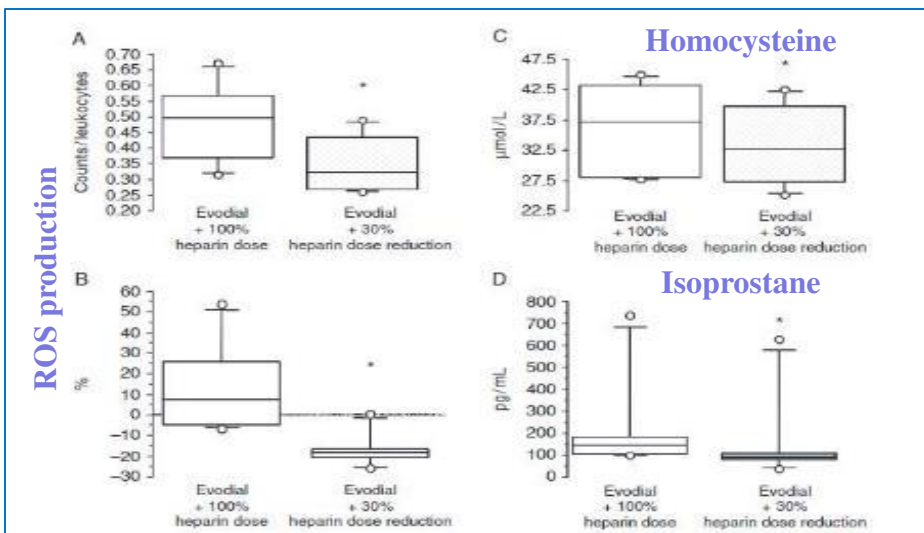
Primary and Secondary Outcomes:

- Efficacy and biocompatibility performances of the Evodial vs a polysulfone membrane with equal effective membrane surface area
- The potential beneficial effects of Evodial dialysers in lowering systemic heparin dose

Biocompatibility of heparin-grafted hemodialysis membranes: impact on MCP-1 circulating level and oxidative status

Results:

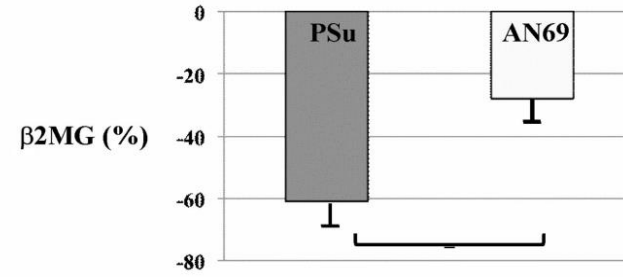
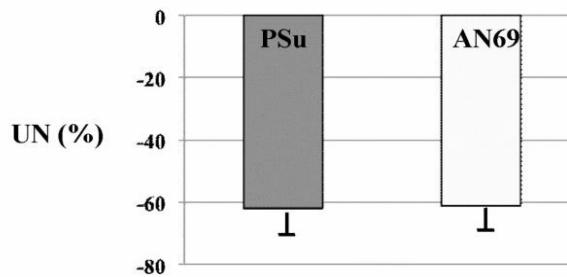
- ✓ Parameters of dialysis efficacy were not significantly different between dialyzers except for β 2M reduction rate
- ✓ No significant difference was observed with parameters of inflammation (IL6, TNF α , RCP, fibrinogen) and oxidative stress
- ✓ By contrast, use of Evodial during 4 weeks was associated with a decrease in postdialysis MCP-1 level



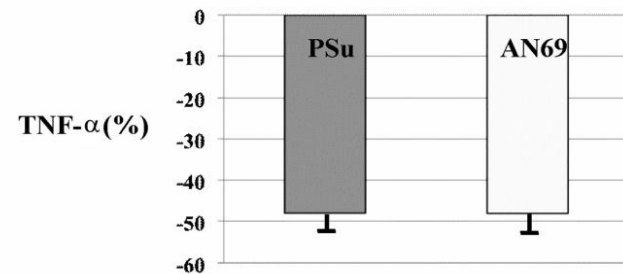
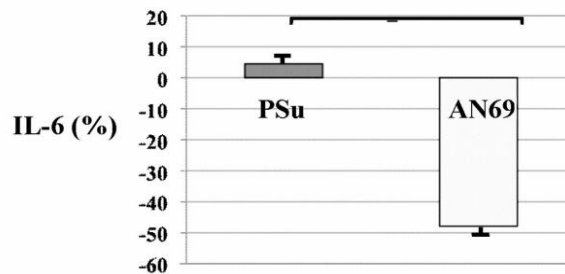
- ✓ The use of Evodial dialyzers with 30% lowering of the dose of systematic heparin was associated with a prevention of oxidative status

A crossover study of the acrylonitrile-co-methallyl sulfonate and polysulfone membranes for elderly hemodialysis patients: The effect on hemodynamic, nutritional, and inflammatory conditions.

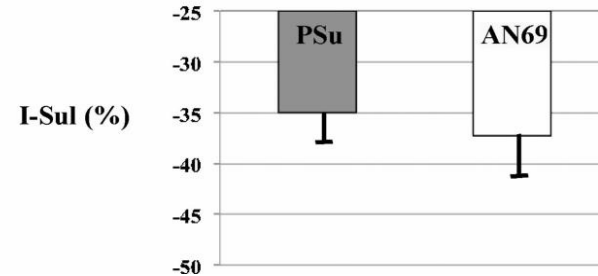
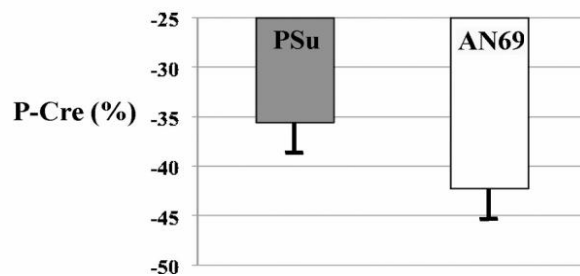
Reduction ratio of uremic toxins (small or middle molecular weight)



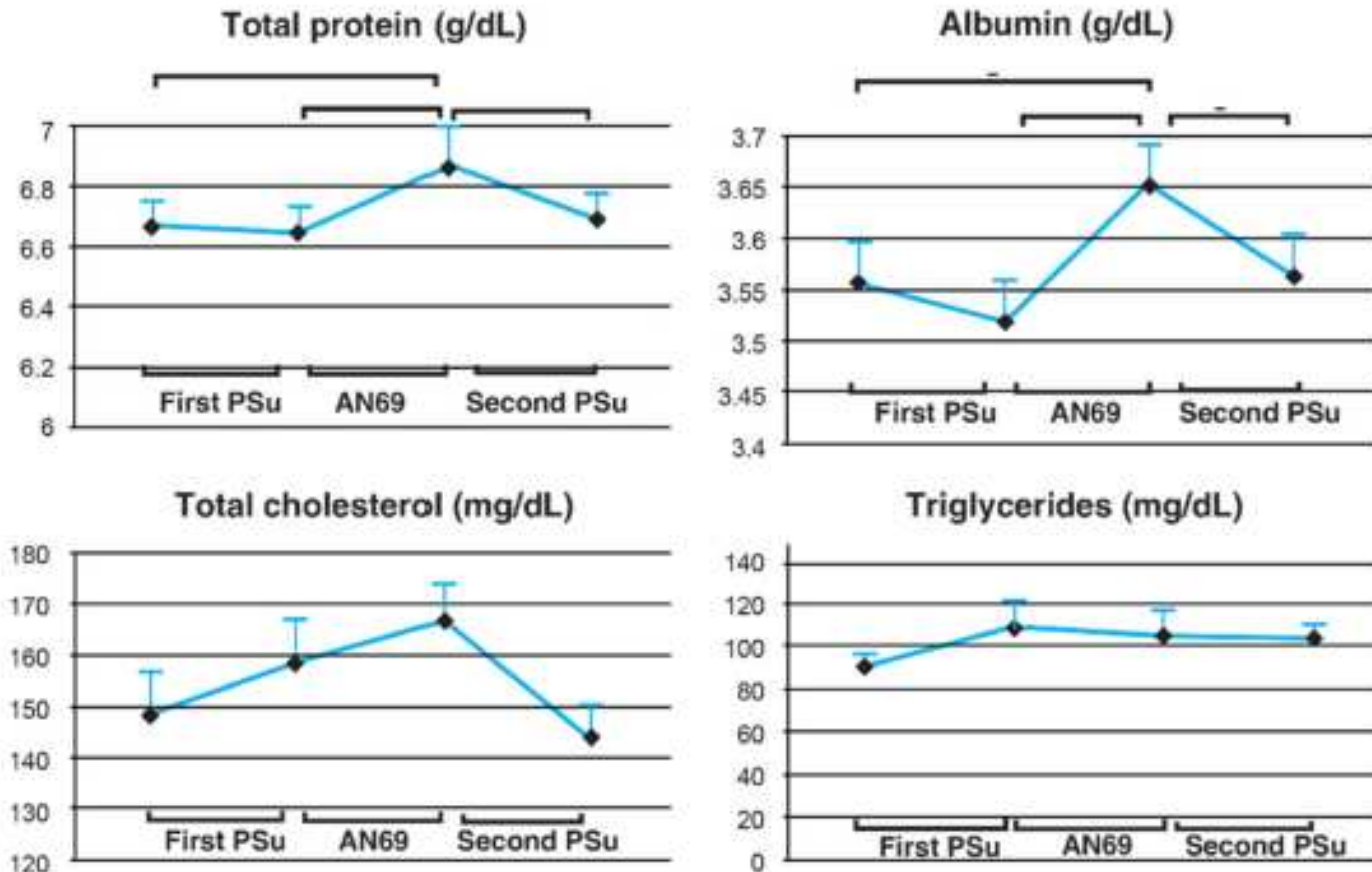
Reduction ratio of inflammatory cytokines



Reduction ratio of protein bound uremic toxins

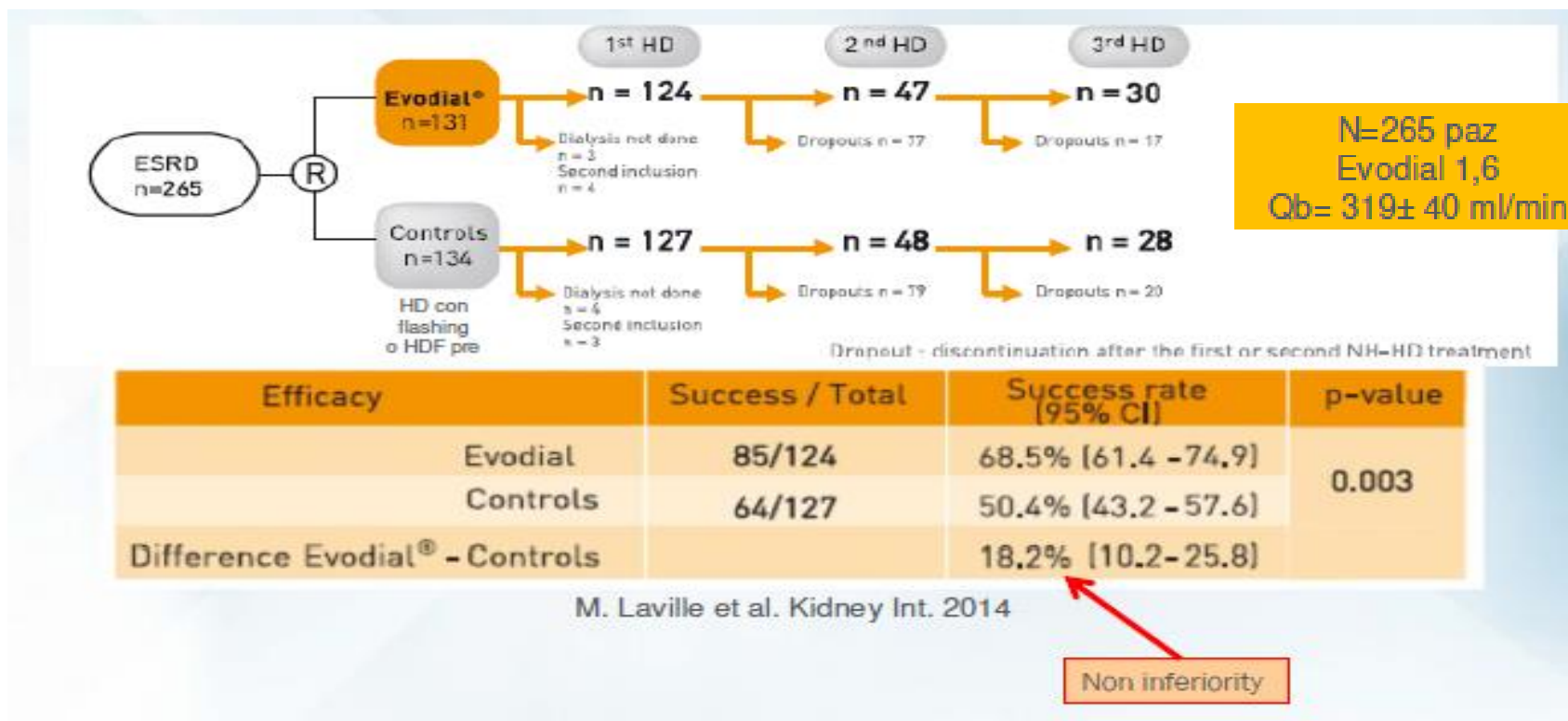


A crossover study of the acrylonitrile-co-methallyl sulfonate and polysulfone membranes for elderly hemodialysis patients: The effect on hemodynamic, nutritional, and inflammatory conditions.



No-heparin hemodialysis: Results of the HepZero Study

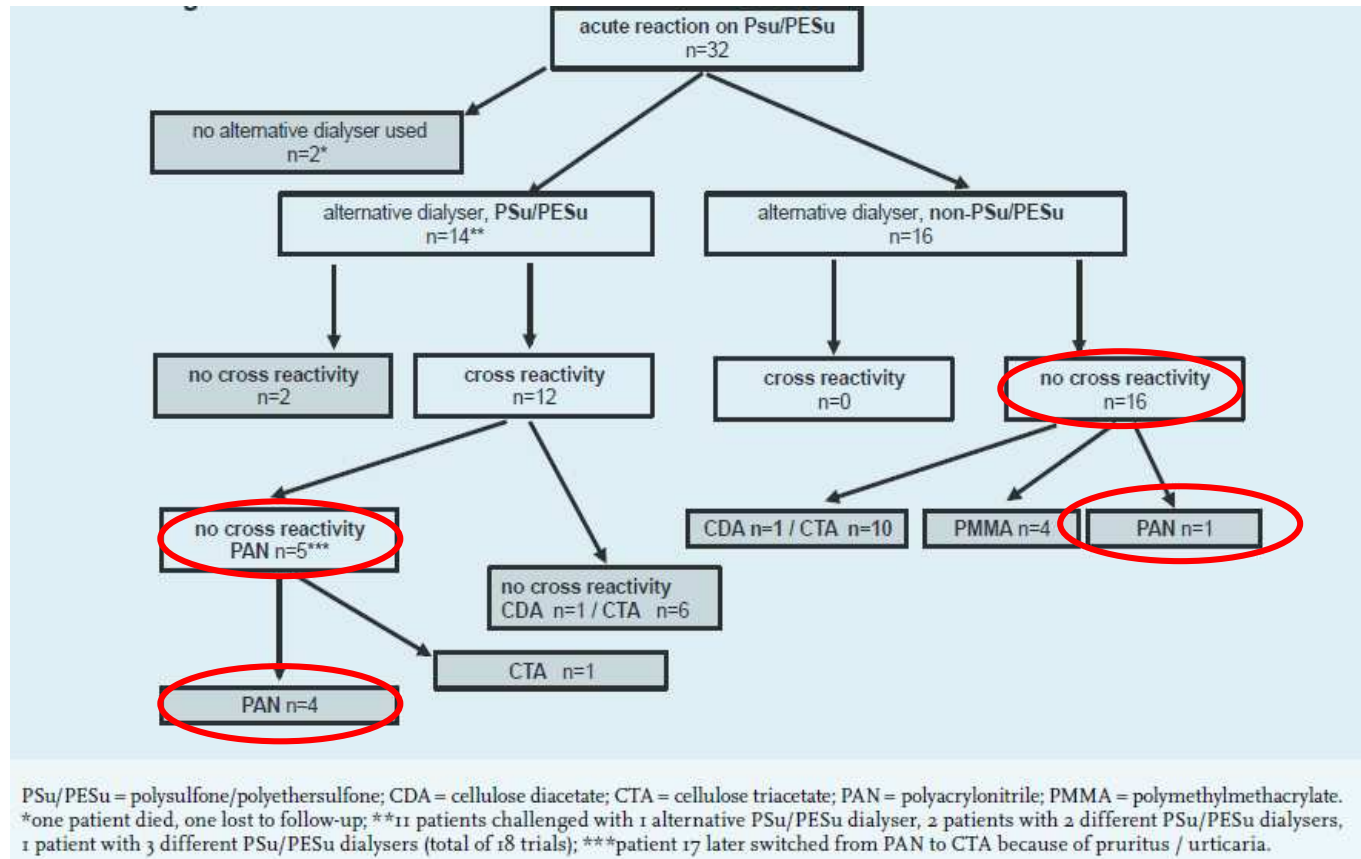
- Prospective, multicenter, international, open label RCT
- Non-inferiority comparison: No-heparin haemodialysis (standard of care) vs heparin grafted dialyser



The heparin grafted membrane is a safe, helpful and easy-to-use method for heparin-free haemodialysis in patients with an increased risk of haemorrhage

Acute reactions to polysulfone/polyethersulfone dialysers: literature review and management

- 32 cases with PES/PS membranes
- ~ 85% of patients switched to a different PS/PES dialyzer had another reaction
- Patients switched to PAN dialyzers had no reactions
- PAN membrane is a suitable alternative for patients who experience reactions to other dialyzers



Patients with acute reactions to PS/PES membranes should be switched directly to non-PS/PES dialyzers, such as CTA (cellulosic), PAN (AN 69), or PMMA, which have demonstrated a better biocompatibility profile

Membrana HeprAN: vantaggi e indicazioni cliniche

- Elevata biocompatibilità



**Sensibilità alle
membrane in
polisulfone**

- Trattamenti con meno/senza eparina



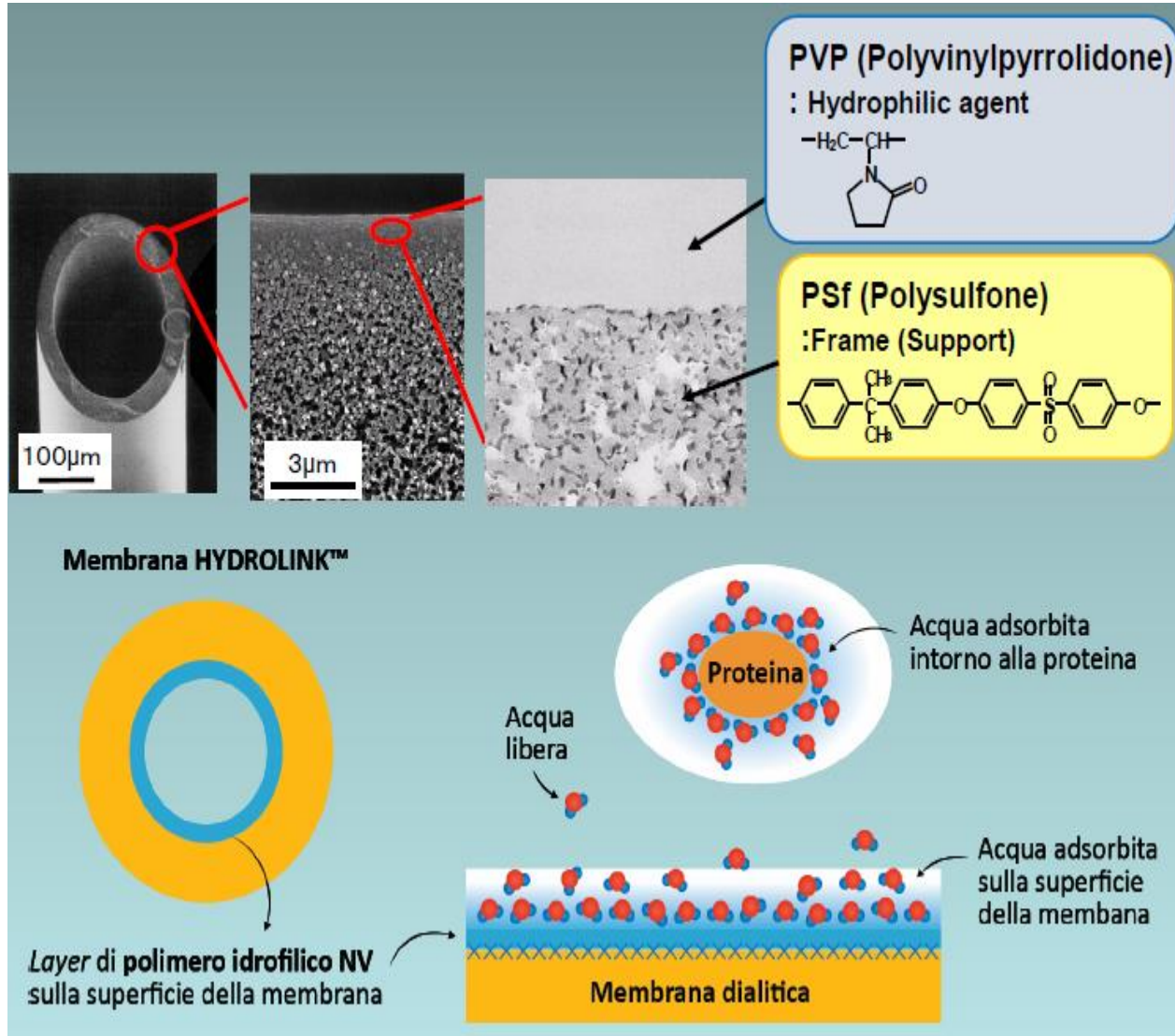
**Emorragia in atto o
elevato rischio
emorragico**

- Limitazione dell'infiammazione,
rimozione mediatori dell'aterosclerosi
e miglioramento stato nutrizionale



Sindrome MIA

Membrane e anticoagulazione: Hydrolink



La membrana HYDROLINK, propone una tecnologia innovativa che adotta l'acqua adsorbita sulla superficie della membrana come unica interfaccia con il sangue, evitando l'adesione delle proteine e la stimolazione delle piastrine.

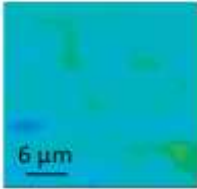
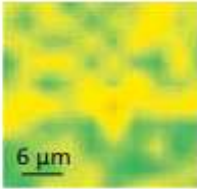

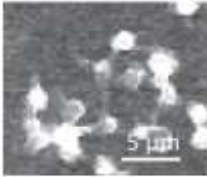
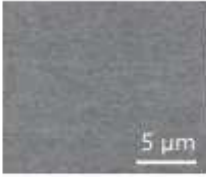
Questa membrana ha la caratteristica di promuovere l'afflusso di acqua dal comparto ematico sulla sua superficie, formando uno strato acquoso continuo che può migliorare l'emocompatibilità del contatto membrana/sangue.

A New Polysulfone Membrane Dialyzer, NV, with Low-Fouling and Antithrombotic Properties

Wataru Oshihara^a · Yoshiyuki Ueno^b · Hiroaki Fujieda^b

Contrib Nephrol 2017

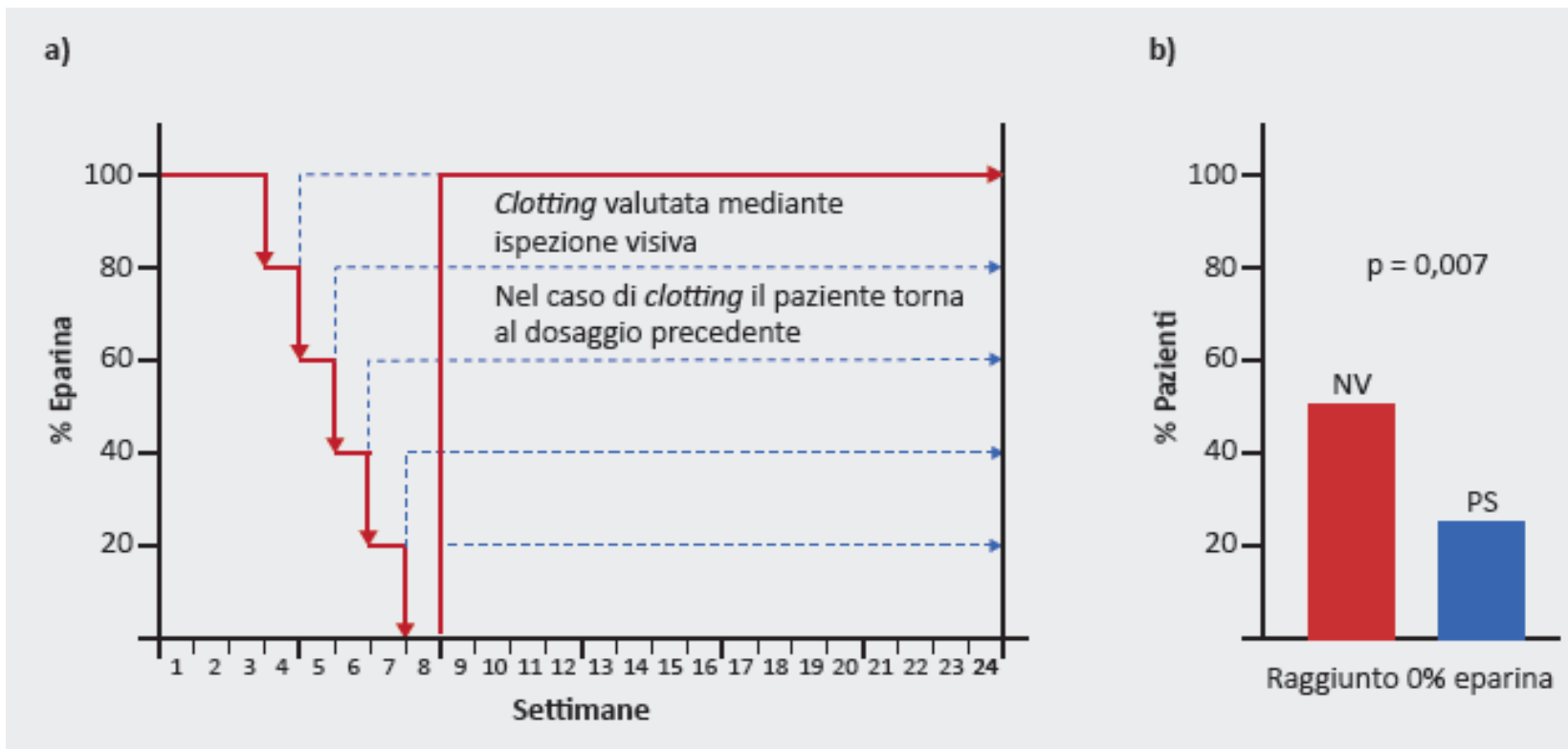
Table 1. Comparison of membrane surface characteristics between a new dialyzer, NV, and a conventional one, CX

		CX (conventional membrane)	NV (new membrane)
Distribution of hydrophilicity on inner surface			
Hydrophilicity	Low  High		
Platelet adhesion test (in vitro)	Scanning electron microscope images of inner surfaces of membrane		
	Count of adhered platelets ¹	100	0.9
Protein adsorption test (in vitro)	Amount of von Willebrand factor adhered on membrane ¹	100	0.4
	Amount of fibrinogen adsorbed on Membrane ¹	100	27
Leukocyte activation test (in vitro)	Relative intensity of CD11b	100	50

HYDROLINK: reduction of heparin during HD treatment

Prospective, randomized, multicenter, controlled trial (TRIATHRON 1) on a new antithrombogenic hydrophilic dialysis membrane

Claudio Ronco^{1,2}, Alessandra Brendolan^{1,2}, Federico Nalesso^{1,2}, Monica Zanella^{1,2}, Massimo De Cal^{1,2}, Valentina Corradi^{1,2}, Grazia M. Virzi^{1,2}, Fiorenza Ferrari², Francesco Garzotto^{1,2}, Anna Lorenzin², Aakash N. Karopadi^{1,2}, Marco Sartori², Silvia De Rosa², Sara Samoni², Faeq Husain-Syed², Alessandra Spinelli², Mauro Neri², Gianluca Villa², Alberta Alghisi²



Results: More patients in the study group reached heparin-free dialysis without clotting events during the heparin reduction test. The NV dialyzers displayed anti-thrombogenic effects as compared to conventional dialyzers.

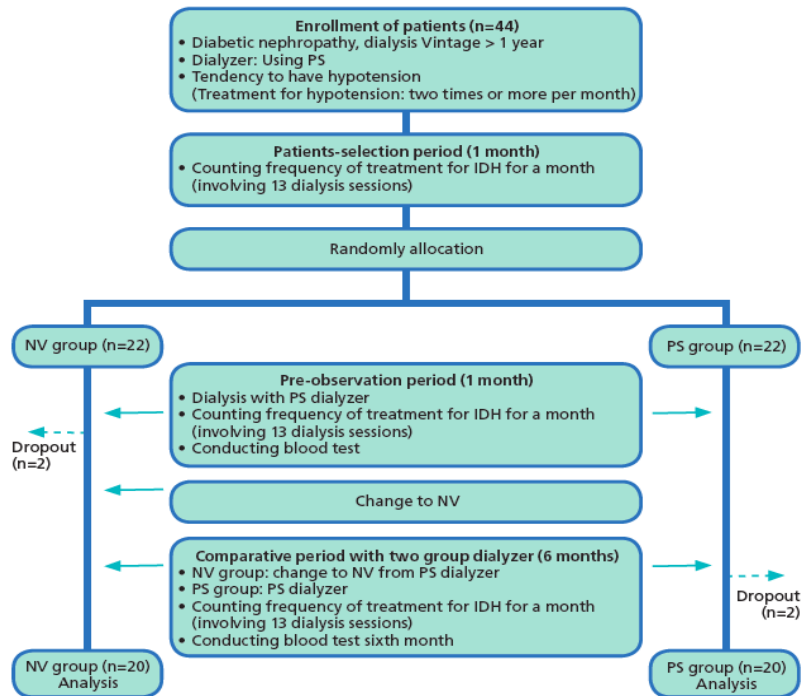


HYDROLINK: reduction of intradialytic hypotension

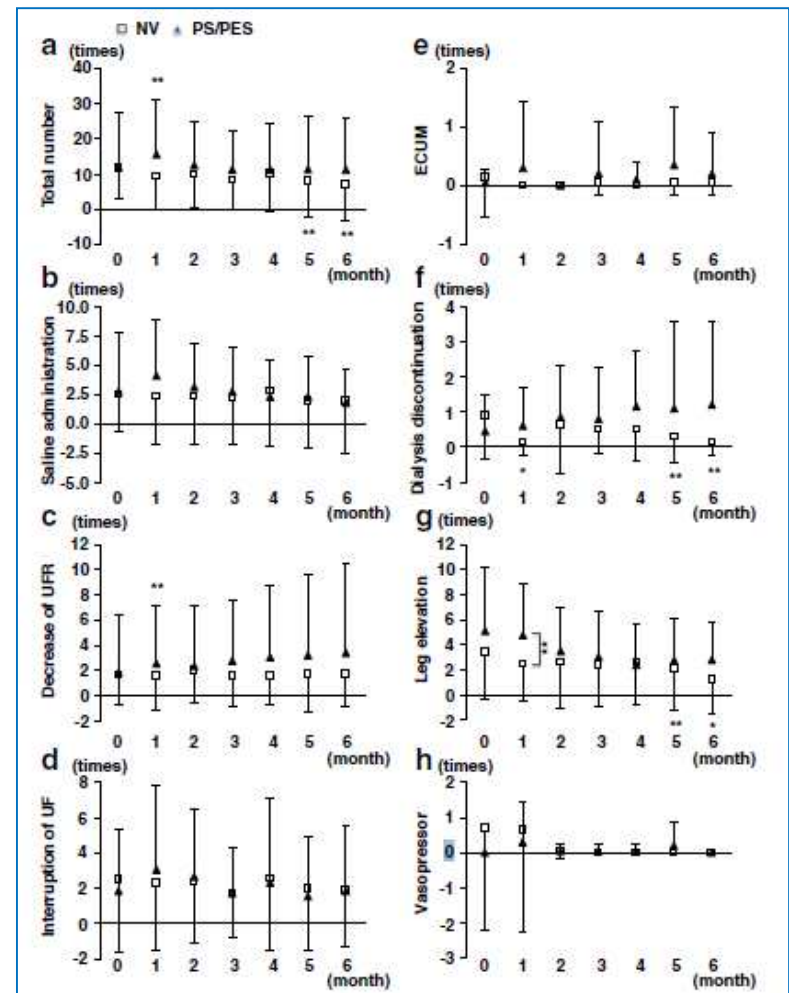
Effects of hydrophilic polymer-coated polysulfone membrane dialyzers on intradialytic hypotension in diabetic hemodialysis patients (ATHRITE BP Study): a pilot study

Kenji Tsuchida^{1*}, Hirofumi Hashimoto², Kazuhiko Kawahara³, Ikuro Hayashi⁴, Yoshio Fukata⁵, Munenori Kashiwagi⁶, Akihiro C. Yamashita⁷, Michio Mineshima⁸, Tadashi Tomo⁹, Ikuto Masakane¹⁰, Yoshiaki Takemoto¹¹, Hideki Kawanishi¹², Kojiro Nagai¹³ and Jun Minakuchi¹³

Figure 1: Study flow diagram



Results: The total number of treatments for IDH decreased significantly in NV group, even though pre-dialysis body weight and ultrafiltration volume were similar. In addition, patients using NV had significantly higher post-dialysis SBP and the lowest SBP during HD at sixth month compared as those in PS/PES group.



Hydrolink: vantaggi e indicazioni cliniche

- **Migliore antitrombogenicità**
- **Eccellente rimozione di tossine uremiche a medio peso molecolare**
- **Potenziale miglioramento ipotensione intradialitica**



**Efficienza dialitica
non adeguata per
ridotta dose
anticoagulazione**



**Frequenti episodi
di IDH**

Take home message

- Ogni membrana ha le proprie caratteristiche in termini di materiale e di performance
- La scelta della membrana dipende dalle necessità cliniche e dialitiche del paziente
- Non esiste la membrana dialitica perfetta, ma la ricerca è in corso

The best way to predict the future is to create it

Peter Ferdinand Drucker (1909 - 2005)

***Grazie per
l'attenzione!***

