УРЕМИЧЕСКИЕ ТОКСИНЫ И ДИАЛИЗНЫЕ МЕМБРАНЫ

ВАЛЕРИЙ ШИЛО, МОСКВА
СЕТЬ КЛИНИК Б. БРАУН АВИТУМ В РФ
КАФЕДРА НЕФРОЛОГИИ МГМСУ ИМ. ЕВДОКИМОВА;
МОСКВА

Разделы презентации

Уремические токсины: основы

Характеристики мембран и диализаторов

Мир диализных мембран: какой вид мембран подходит большинству пациентов на программном гемодиализе?

Что нового ?

Заключение

Уремические токсины - 2019

European Uremic Toxin (EUTox) Work Group of the ESAO and endorsed Work Group of the ERA-EDTA

Solutes in database	130
Solutes by class	67 (51.54%): Water-soluble 33 (25.38%): Protein-bound 30 (23.08%): Middle molecule
Protein-bound solutes above/below 500 Dalton	25 (75.76%): Below 500 Dalton 8 (24.24%): Above 500 Dalton
Total study count	442
CN study count	172 (1.32 per solute)
CU study count	270 (2.08 per solute)
Pathological associations count	75 (0.58 per solute)
Pathological associations	31 (41.33%): Cardiovascular 13 (17.33%): Nephrologic 7 (9.33%): Neurologic and CNS 5 (6.67%): Oncologic 4 (5.33%): Immunologic

Name	β-2-Microglobulin
Molecular weight	11818
Group	Peptide
Class	Middle molecule
Added	16.09.2009
Reference	Pubmed: 12675874
Submitted by	Vanholder
Reviewed by	Abou Deif

NORMAL CONCENTRATIONS (CN)

Date	**Mean (+/-SD) (low Range - high Range)**
05.07.2001	1.17 (+/-0.40) mg/L
03.01.2007	(1.10-2.40) mg/L
08.03.2011	1.90 (+/-0.60) mg/L
Grand mean	**1.50 (+/-0.50) (1.10-2.40) mg/L**
ANOVA	**F(1,45) = 24.87, p=0.00: Significant differen**
Dispersion	**L:1.10, M:1.50, H:2.40 : A - (Minimal scatter:**

http://www.uremic-toxins.org

Уремические токсины – 2019 – ревизия?

Small (<500 Daltons)	**Medium (500–15,000 Daltons)**	**Large (>15,000 Daltons)**	**Protein-bound* (Daltons)**
Sodium (23) Phosphorus (31) Potassium (35) Urea (60) Creatinine (113) Uric acid (168) Glucose (180)	Vitamin B12 (1355) Vancomycin (1448) ANP (3100) Endothelin (4300) Insulin (5200) PTH (9225) β_2-Microglobulin (11,800) Resistin (12,500) Cholecystokinin (12,700) Cystatin C (13,300)	Cytokines (15,000–30,000) Myoglobin (17,000) Kappa FLC (22,500) Complement factor D (27,000) FGF-23 (32,000) α1-Microglobulin (33,000) Erythropoietin (34,000) Lambda FLC (45,000) Albumin (68,000) AOP (various) AGEP (various)	Phenol (94) *p*-Cresol (108) Homocysteine (135) Indole-3-acetic acid (175) Hippuric acid (179) Carboxymethyl-lysine (204) Indoxyl sulfate (251) Acrolein (56)

Уремические токсины – 2019 – ревизия малые молекулы

	MW (Da)	Source	Metabolism	Toxicity
Urea [6]	60.05	Dietary proteins	Hepatic	Vascular disease, insulin resistance (in vivo data)
ADMA [24]	202.25	Protein metabolism	Endogenous enzymes	Vascular disease
TMAO [15]	75.11	Diet	Hepatic	Vascular disease, renal fibrosis
Uric acid [18, 19, 20]	168.11	Purine metabolism	Endogenous enzymes	Accelerated CKD, vascular disease, hypertension

ADMA, asymmetric dimethylarginine; TMAO, trimethylamine-N-oxide

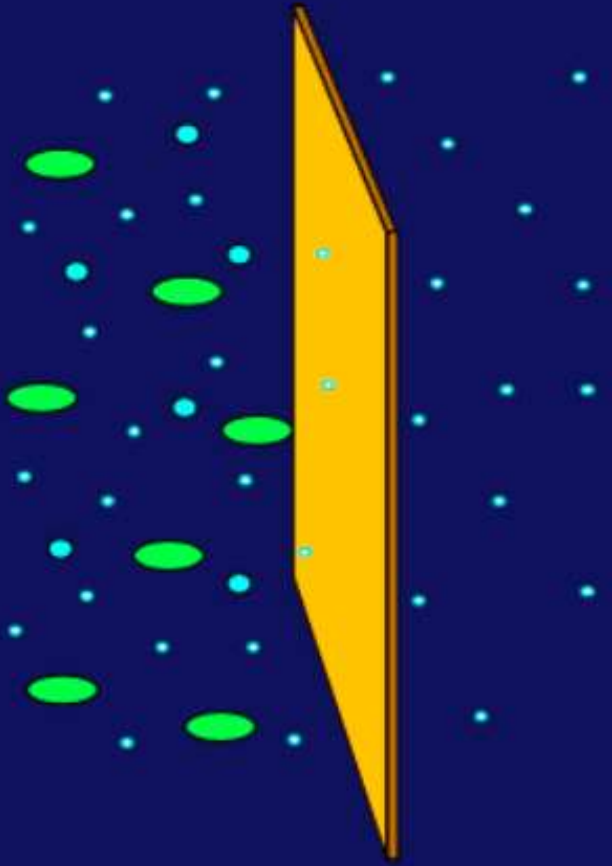
Уремические токсины – 2019 Среднемолекулярные

	MW (Da)	Source	Toxicity
β_2-Microglobulin [25]	11,729	Major histocompatibility complex	Amyloid bone and joint disease, vascular wall infiltration
Leptin [28]	16,000	Endogenous	Malnutrition

Aspects in Dialysis
2018

Механизмы удаления токсинов

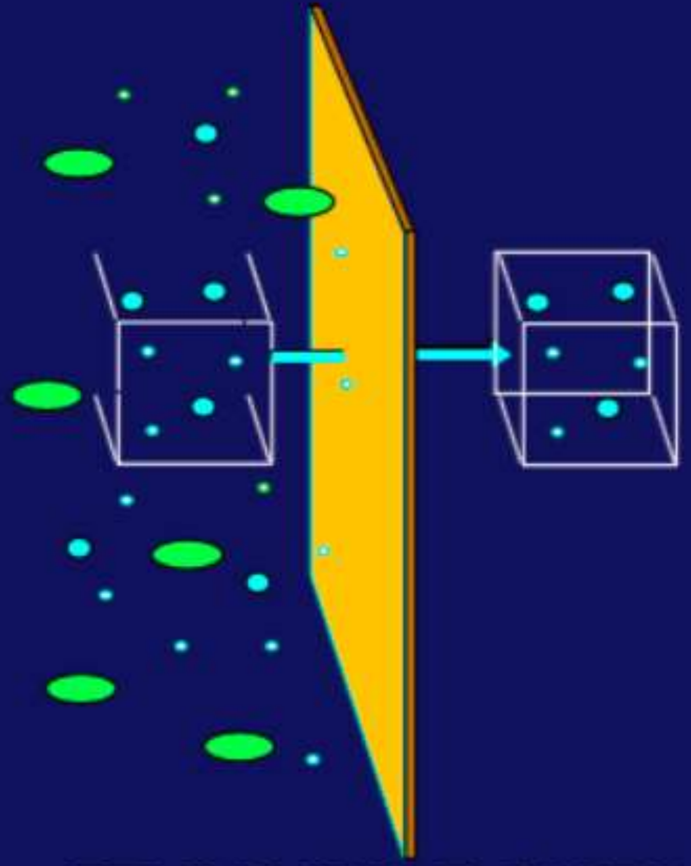
Диффузия



ДВИЖУЩАЯ СИЛА

Градиент концентрации

Конвекция



ДВИЖУЩАЯ СИЛА

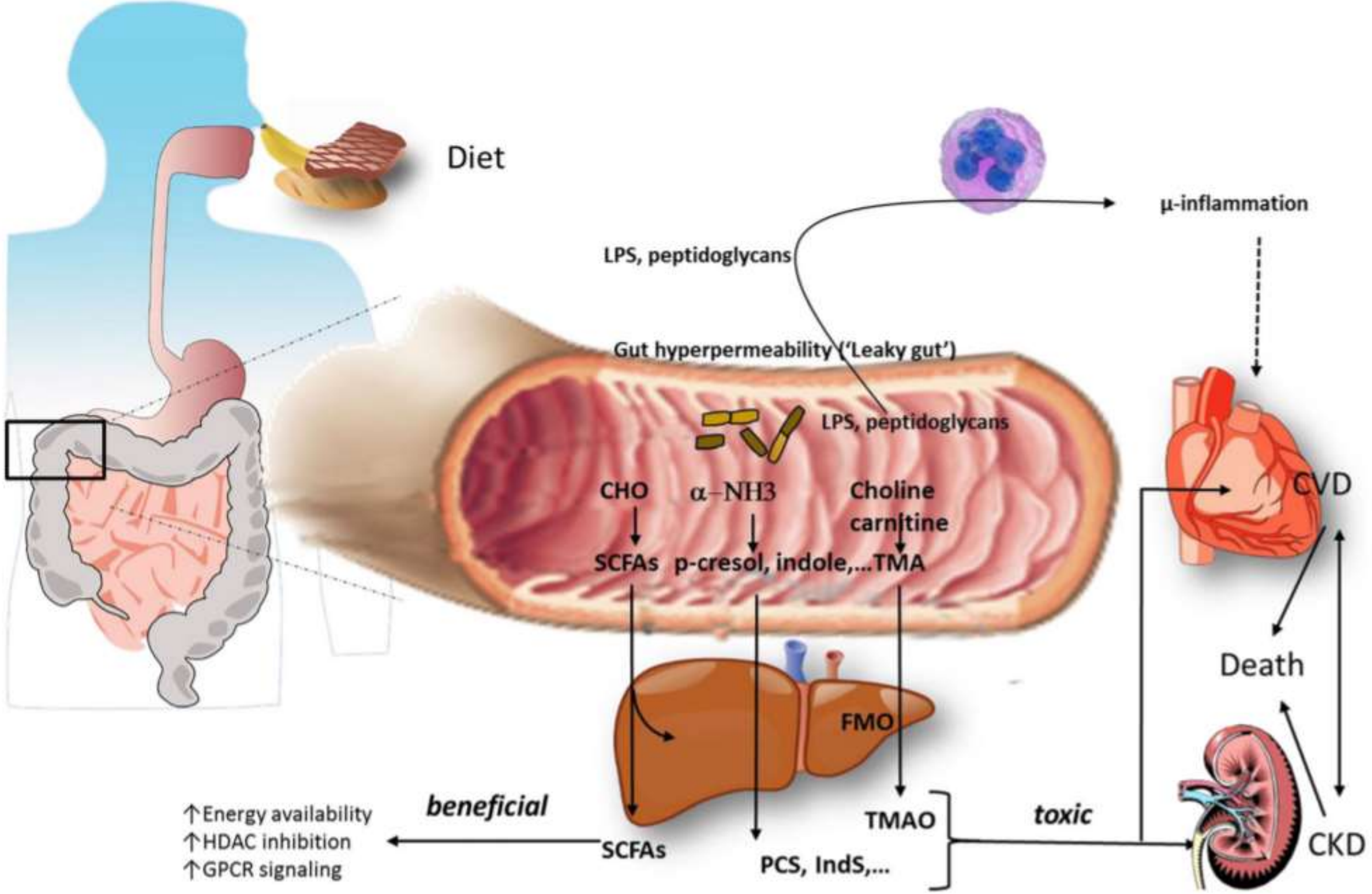
Трансмембр. Давление

Aspects in Dialysis 2018

Уремические токсины – Связанные с белками малые молекулы

	MW (Da)	Source	Metabolism	Toxicity	Percent unbound
Indoxyl sulfate [37, 38, 45, 46, 47, 48]	251.30	Tryptophan	Gut microbiome, hepatic	Cardiovascular	~10%
p-Cresyl sulfate [37, 38, 45, 46]	188.19	Tyrosine	Gut microbiome, hepatic	Cardiovascular	5–10%
Kynurenine [41, 42, 43]	208.21	Tryptophan	Primarily hepatic, also immune cells	CNS	N/A
Kynurenic acid [41, 42, 43, 52]	189.17	Tryptophan	CNS	CNS	14%
Quinolinic acid [41, 44]	167.12	Tryptophan	Brain microglia	Bone marrow, CNS	N/A
CMPF [38]	240.25	Furanoid fatty acids	Endogenous enzymes	Bone marrow, thyroid, albumin drug binding	<1%

Ось кишечник – почки: решающая роль в продукции уремических токсинов, связанных с белками



Evenepoel, P., Poesen, R., & Meijers, B. (2016). The gut–kidney axis.

Виды процедур и удаление токсинов

- Малые водорастворимые молекулы – ГД, ГДФ, ГФ, в небольшой степени ИУФ
- Малые молекулы связанные с белками – плохо удаляются ГД, ГДФ, ГФ, выводится только свободная фракция, удаление зависит от степени связи с белком, объема распределения и времени процедуры
- Средние молекулы – хорошо удаляются ГДФ, хай-флакс диализом, ГФ, и практически не выводятся стандартным диализом лоу-флакс

Материал мембраны определяет

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физические размер пор, производительность сорбционные свойства

Химические, биологические гидрофобность биосовместимость, гемосовместимость

Медицинские, клинические безопасность, побочные эффекты

свойства мембран в клиническом применение

Синтетические мембраны наиболее оптимальны

Целлюлозные мембраны

Немодифицированные

- Купрофан
- Диацелл
- Омыленный эфир целлюлозы (SCE)

Модифицированные

- Ацетат, диацетат,
- триацетат целлюлозы

- Покрытые

- Биомембрана
- PEG-целлюлоза

- Синтетически
- модифицированные

- Гемофан
- Эфир-бензил-целлюлоза

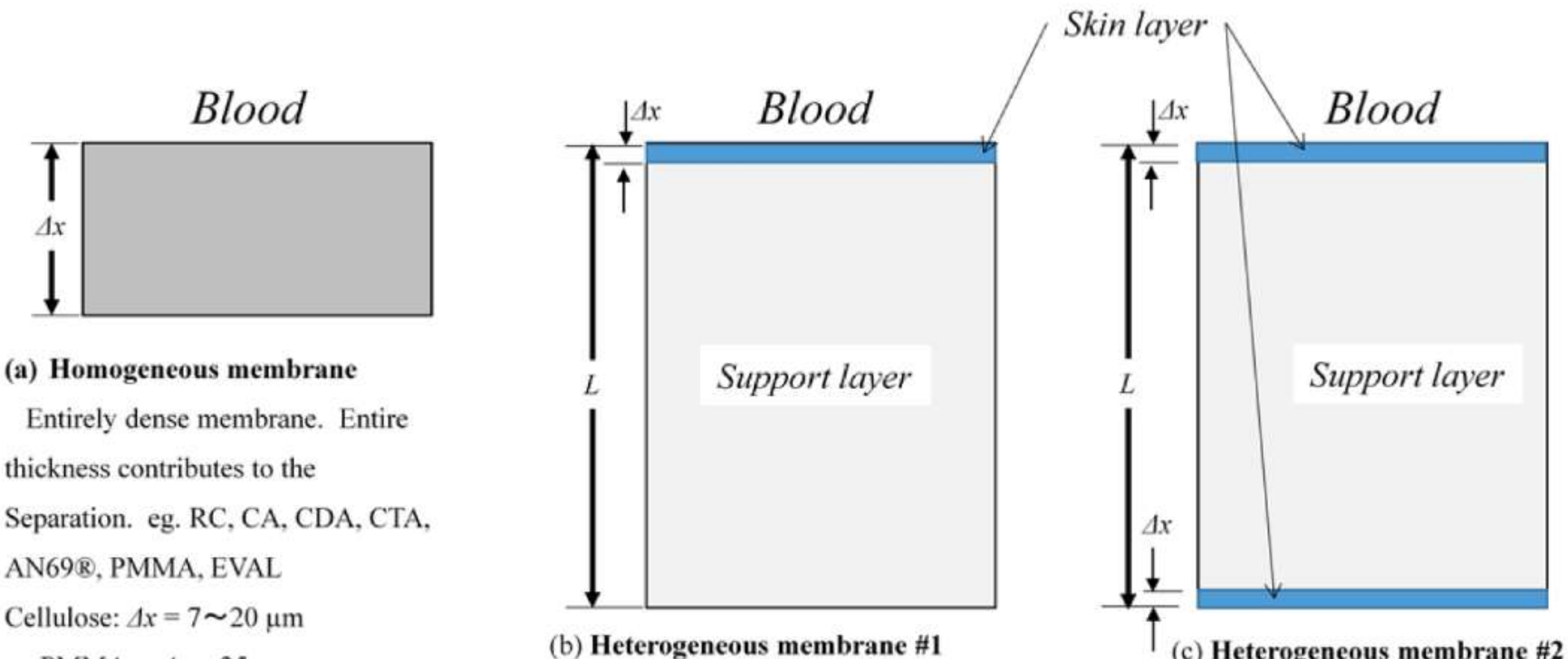
Синтетические мембраны

Полисульфон PS, PS-PVP
полиэфирсульфон (PES, PAES*)
AH69
ПММА
Поликарбонат
Полиамид

Композитные мембраны

*poly(ethersulfone) (PES) ultrafiltration membrane blended with poly (acrylic acid) (PAA)

Отличия симметричной и ассиметричной мембраны



(a) Homogeneous membrane

Entirely dense membrane. Entire thickness contributes to the Separation. eg. RC, CA, CDA, CTA, AN69®, PMMA, EVAL

Cellulose: Δx = 7∼20 μm

PMMA: Δx = 25 μm

(b) **Heterogeneous membrane #1**

Composed of a dense skin layer with Δx and a support layer with $L - \Delta x$.

eg. PSf, PES, PAN

Δx = 0.5∼2 μm

L = 25 ∼ 40 μm

(c) **Heterogeneous membrane #2**

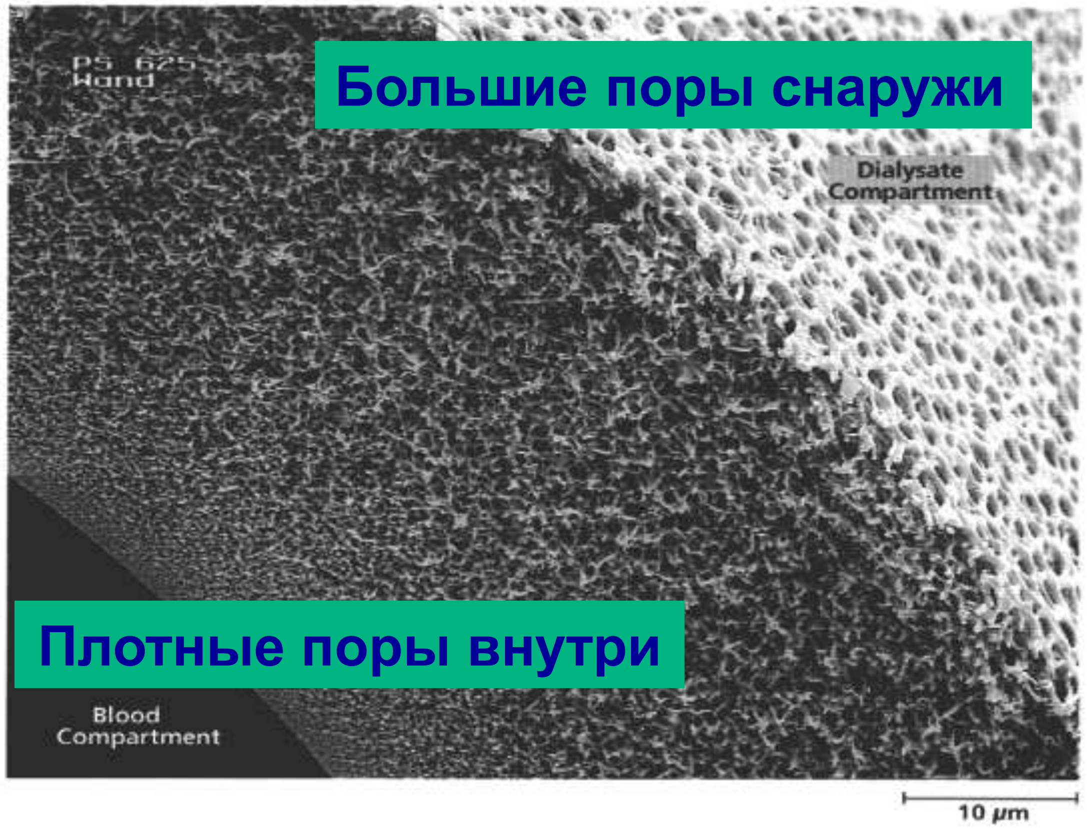
Composed of two dense skin layers inside and outside.

eg. PEPA

Δx = 0.5∼2 μm

L = 25 ∼ 40 μm

Структура мембраны полисульфон: асимметричная



Баланс между прочностью и сопротивлением

PES, PS и PAES- особенности

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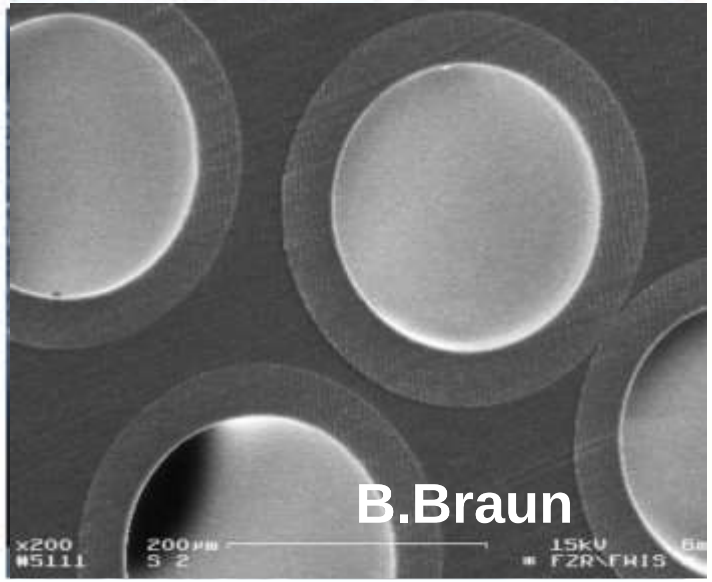

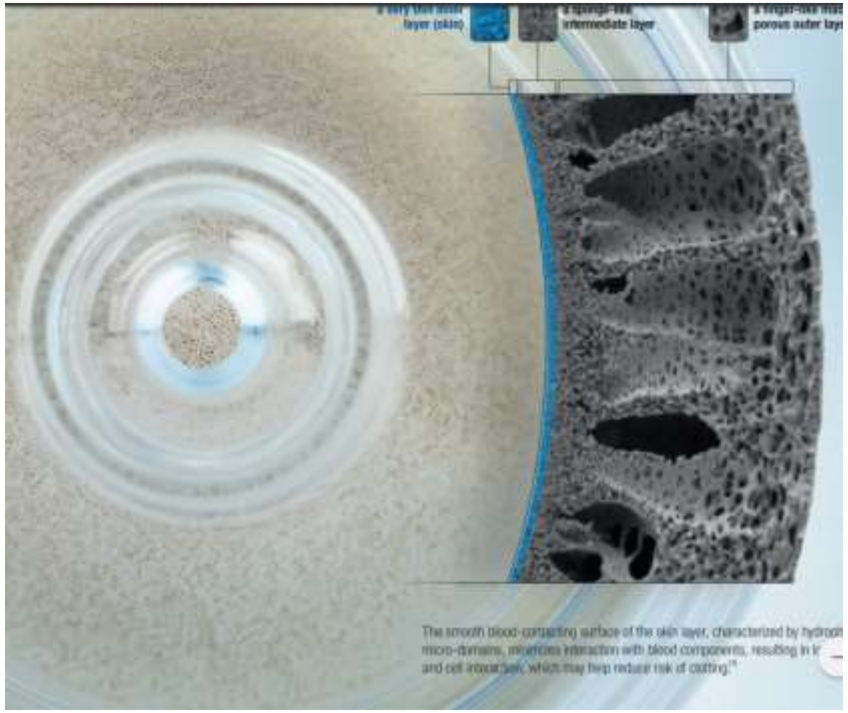

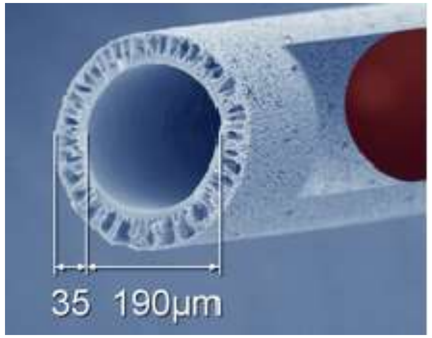

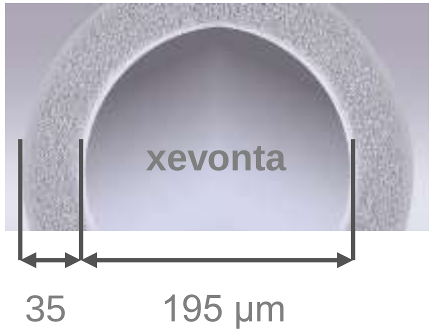

Table 6
Membrane characteristics of commercial HD membrane.

	High-flux polyethersulfone			High-flux polysulfone	
	PUREMA® H	**Diapes® HF800**	**Helixone®**	**Toraysulfone (TS-S/U series)**	**Asahi Polysulfone (APS)**
Membrane material	PES-PVP blend	PES-PVP blend	PSU-PVP blend	Crosslinked PSU- PVP	Polysulfone
Wall structure	Asymmetric	Asymmetric	Asymmetric	Asymmetric	Asymmetric
Fibre diameter (µm)	200	200	185	200	200
Wall thickness (µm)	30	30	35	40	45
Cytochrome c	0.95 ± 0.04	0.60 ± 0.05[a]	0.61 ± 0.07[a]	-	-
Albumin	0.001 ± 0.001[b]	0.005 ± 0.002	0.001 ± 0.001[b]	-	-
Ultrafiltration coefficient (ml/h m^2.mmHg)	85.3 ± 11.7[c]	82.6 ± 11.5[c]	62.2 ± 12.5	-	69
Sterilization	Gamma-ray	Gamma-ray	Inline steam	-	Gamma-ray
Ref.	[159]	[158]	[158]	[161]	[162]

[a] $P < 0.001$ vs PUREMA® H; [b] $P < 0.001$ vs Diapes® HF800; [c] $P < 0.01$ vs Helixone®

Композитные мембраны

Мир современных гемодиализных мембран

- Низкопроницаемые мембраны LFHD
- **Низкопроницаемые мембраны с высоким КоА LFHEHD**
- Высокопроницаемые мембраны HFHD
  - Покрытые мембраны (вит Е, гепарин), **технология Endexo**
  - Адсорбирующие белок мембраны
  - Сверхпроницаемые мебраны, или альбумин-проницаемые мембраны (HCO), допускающие потери белка (до 4 г)
- **Высокопроницаемые селективные мембраны HFHD, HDF**
- Высокопроницаемые мембраны с отсечкой больших средних молекул (MCO) HFHD (Увеличен размер пор = неизбежна потеря альбумина- - какая потеря допустима?)

Выведение альфа-1-мг и потери белка

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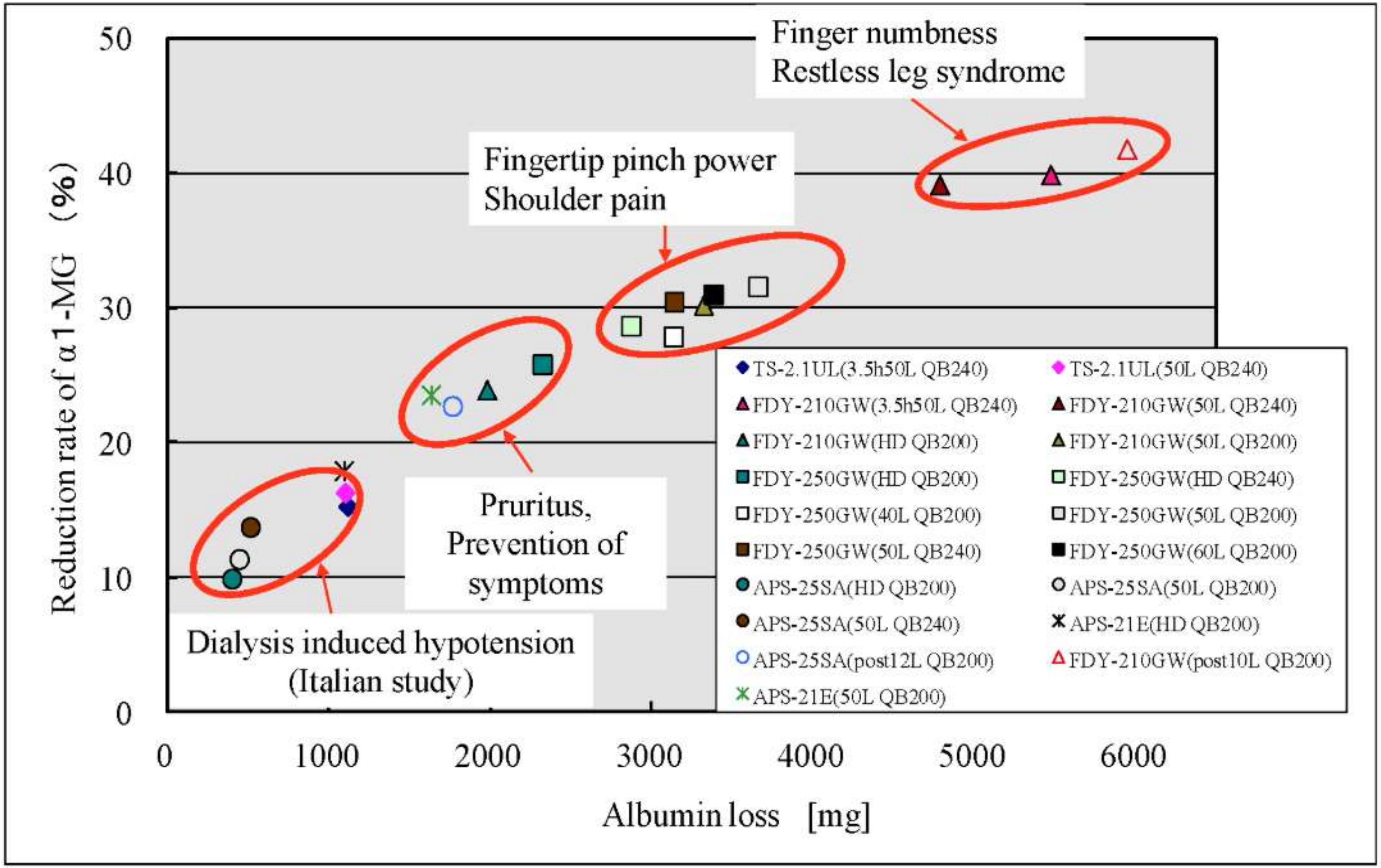

Расширенный гемодиализ - NDT 2018 Florence

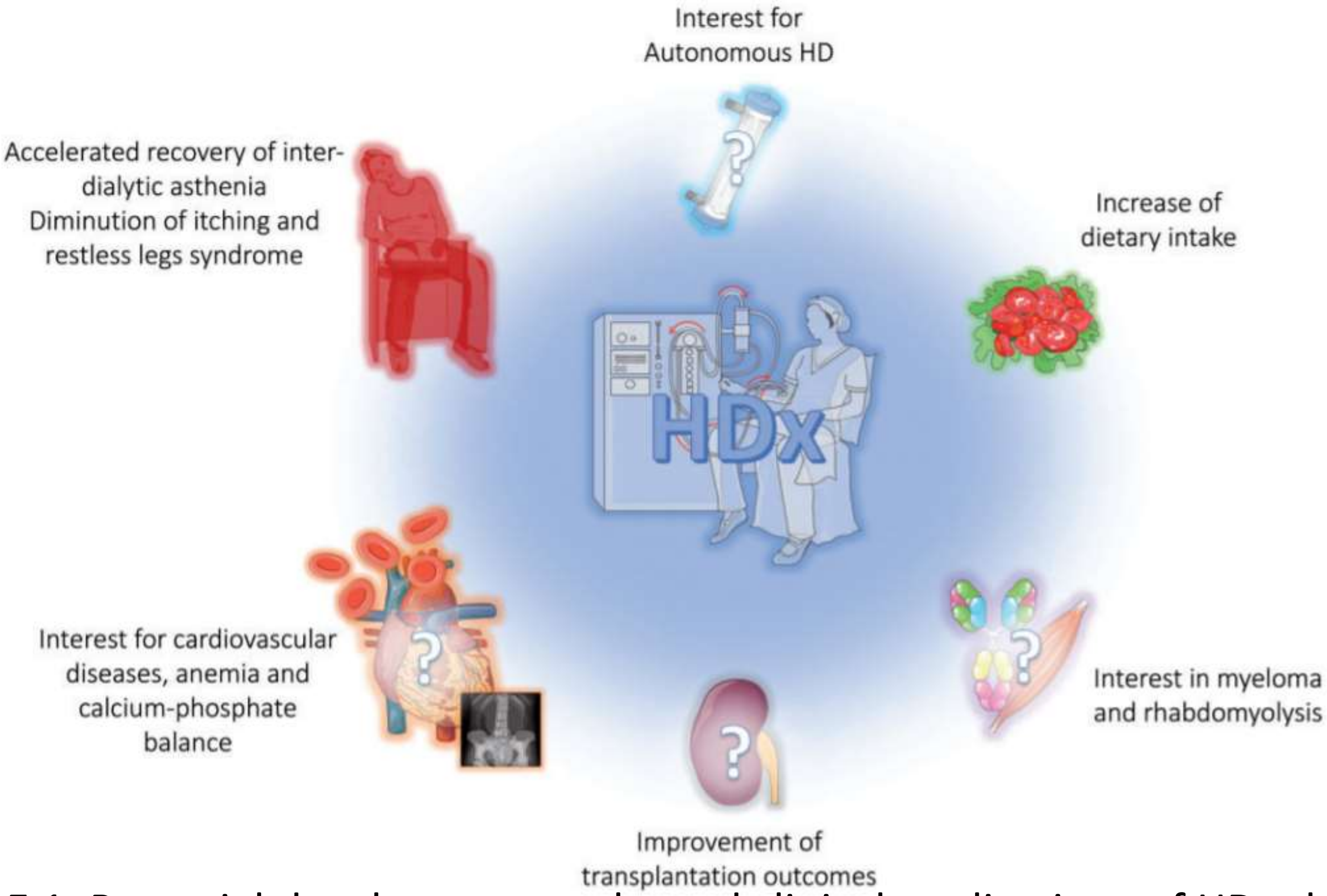

FIGURE 1: Potential development paths and clinical applications of HDx therapy.
Nevertheless, interventional studies are required to confirm or overturn these statements.

Expanded haemodialysis: news from the field

CLINICAL PRACTICE?

Nephrol Dial Transplant (2018) 33: iii48–iii52

ndt Nephrology Dialysis Transplantation

When?	Why?	Level of proof
When HDF is not possible or valuable		
• Difficulty to achieve the targeted post-reinjection volume • Logistical issues (single-needle puncture and other temporary vascular access malfunction, water loop maintenance . . .)	HDx may have the same effectiveness of removal of middle molecules as HDF	No proof Real benefits are unknown, and further studies are needed
Pruritus and RLS		
• After the failure of all the routinely used medical interventions • After a well-conducted work-up for secondary causes	HDx could improve the removal of larger uraemic toxins such as FLC, myoglobin	No proof Case report Real benefits are unknown, and further studies are needed
Asthenia and timeliness of recovery after a HD session		
• Based on patient's grievances	Better biocompatibility?	No proof Case report

ontinued

When?	Why?	Level of proof
	Role of large middle molecules?	Real benefits are unknown, and further studies are needed
Cardiovascular and transplantation outcomes		
Not defined yet	Better removal of large middle molecules?	No proof Real benefits are unknown, and further studies are needed
Self-care haemodialysis		
Whenever HDx is medically appropriated	Better removal of uraemic toxins such as high flux HD?	No proof Real benefits are unknown, and further studies are needed

Received: 31 January 2019 | Revised: 24 April 2019 | Accepted: 26 April 2019
DOI: 10.1111/aor.13480

MAIN TEXT ARTICLE

Artificial Organs WILEY

High-permeability alternatives to current dialyzers performing both high-flux hemodialysis and postdilution online hemodiafiltration

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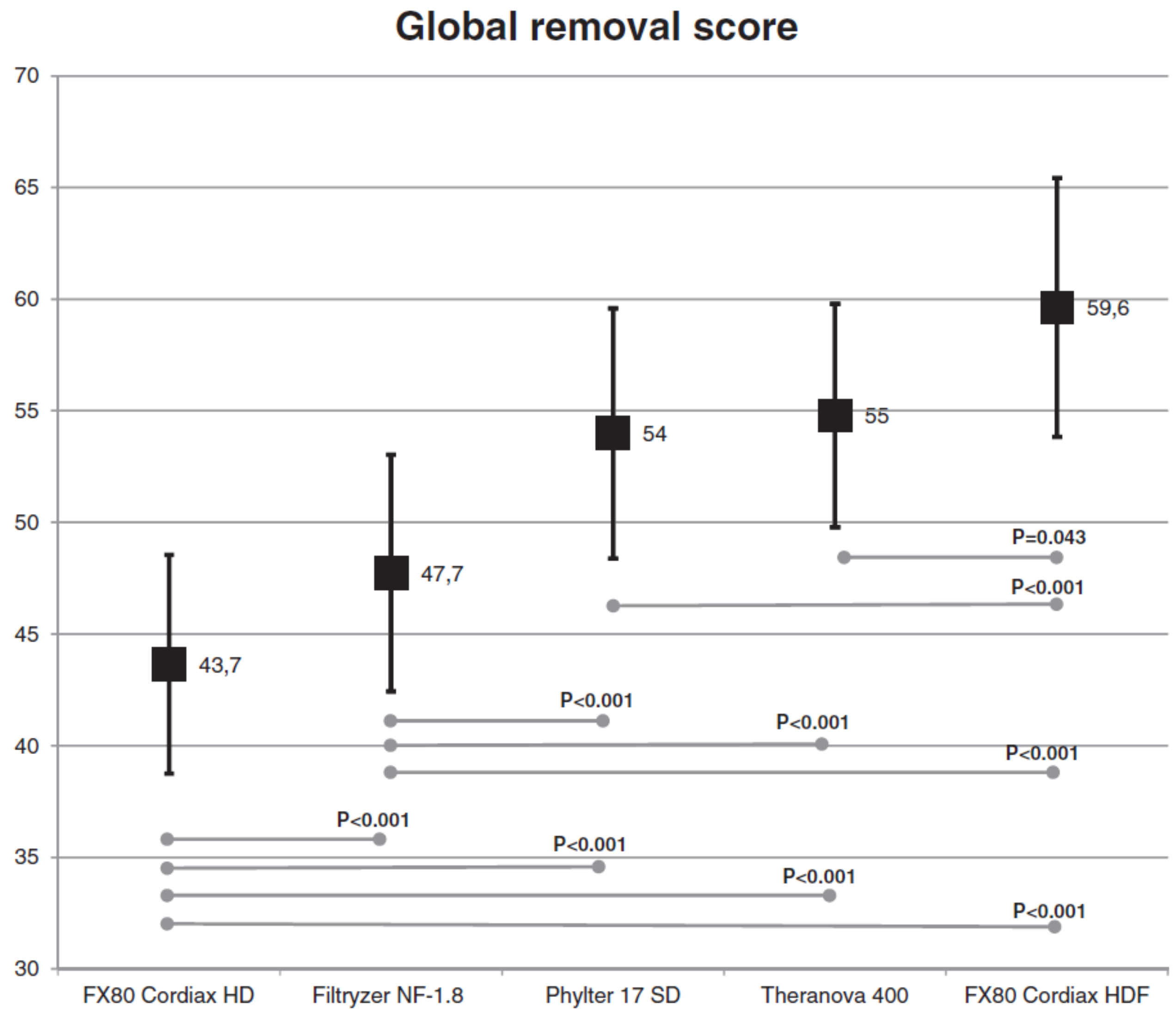


FIGURE 2 Global evaluation of removal efficacy for medium-size molecules and albumin loss in all study situations. (ANOVA for repeated data). Global removal score = (urea$_{RR}$ + β_2-microglobulin$_{RR}$ + myoglobinRR + prolactin$_{RR}$ + α_1-microglobulin$_{RR}$ + α_1-acid glycoprotein$_{RR}$ − albumin$_{RR}$)/6

Clinical Study to Assess the Performance of a Novel Dialyzer with Endexo™ in ESRD Subjects

BACKGROUND

Surface modifying macromolecules (SMM) may improve the hemocompatibility of hemodialyzers in the development of heparin free hemodialysis (HD). The aim of this clinical trial was to assess the performance and safety of a new dialyzer using a novel fluorinated SM additive (Endexo™) in ESRD Subjects.

METHODS

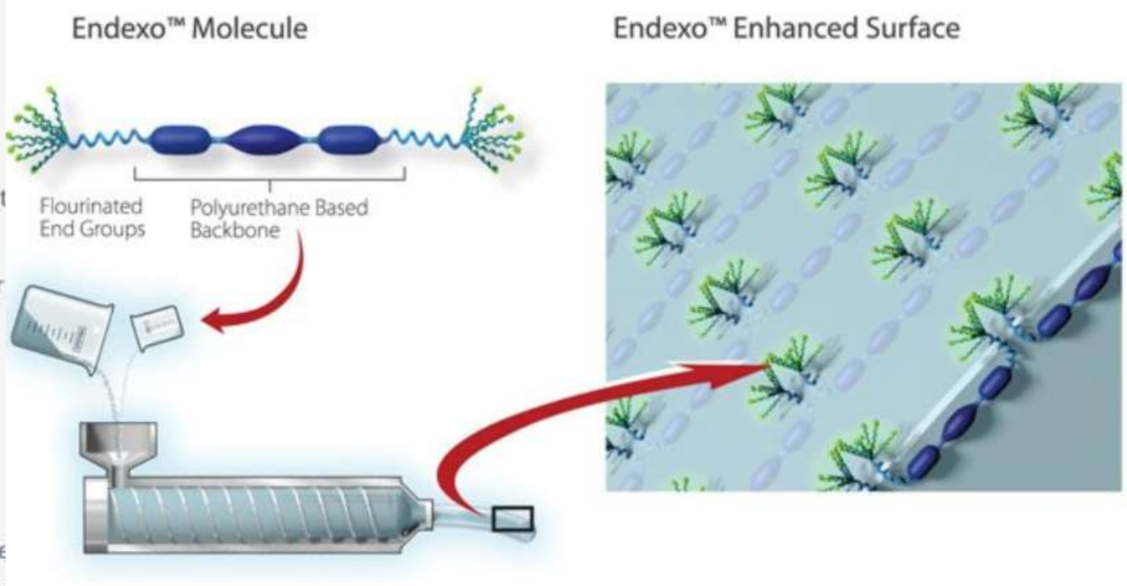
This prospective, sequential, multi-center, open-label study (NCT# 03536663) was designed according to the FDA's Guidance for the premarket testing of hemodialyzers. Adult subjects, prescribed thrice-weekly HD for at least 180 days, were enrolled at 3 HD clinics in t US. After completing 12 HD sessions (4 weeks) with an Optiflux® F160NR dialyzer (Opti), subjects received 36 HD sessions with the dialyzer with Endexo (EndX). Evaluated parameters included spKt/V, URR, albumin, β2-microglobulin (β2M), complement activation for Opti and EndX, and hemoglobin and platelet count for EndX only.

RESULTS

A total of 23 subjects (60.5±15.1 yr., BW 70.9±17.4 kg, 17 males) were enrolled and 17 subjects completed the study, 6 subjects were withdrawn due to missed visits not related to the dialyzers. Mean treatment times (208 vs. 207 min), blood flow rates (447.7 vs. 447.5 ml/min), dialysate flow rates (698.5 vs. 698.0 ml/min), URR (80%± 8 vs. 80.2%±4.8) and spKt/V (2.0±0.43 vs. 1.9±0.31) were comparable for EndX and Opti, respectively. There was no evidence of overt complement activation as C5a and C3a levels remained unchanged fro pre-HD, and a slight trend for increase in sC5b-9 levels at 30 min was observed for both dialyzers. Comparable increase in serum albur was observed from pre to post HD, 7.45%±8.5 Opti and 7.40%±7.4 EndX, however, β2M removal rate was 67% higher with EndX vs. Op Post-HD hemoglobin increased by 4.75%±8.2 vs. pre-HD (EndX), and post-HD platelet count decreased by 2.7%±5.6 vs. pre-HD (EndX). Three serious adverse events were reported, none of them were device related.

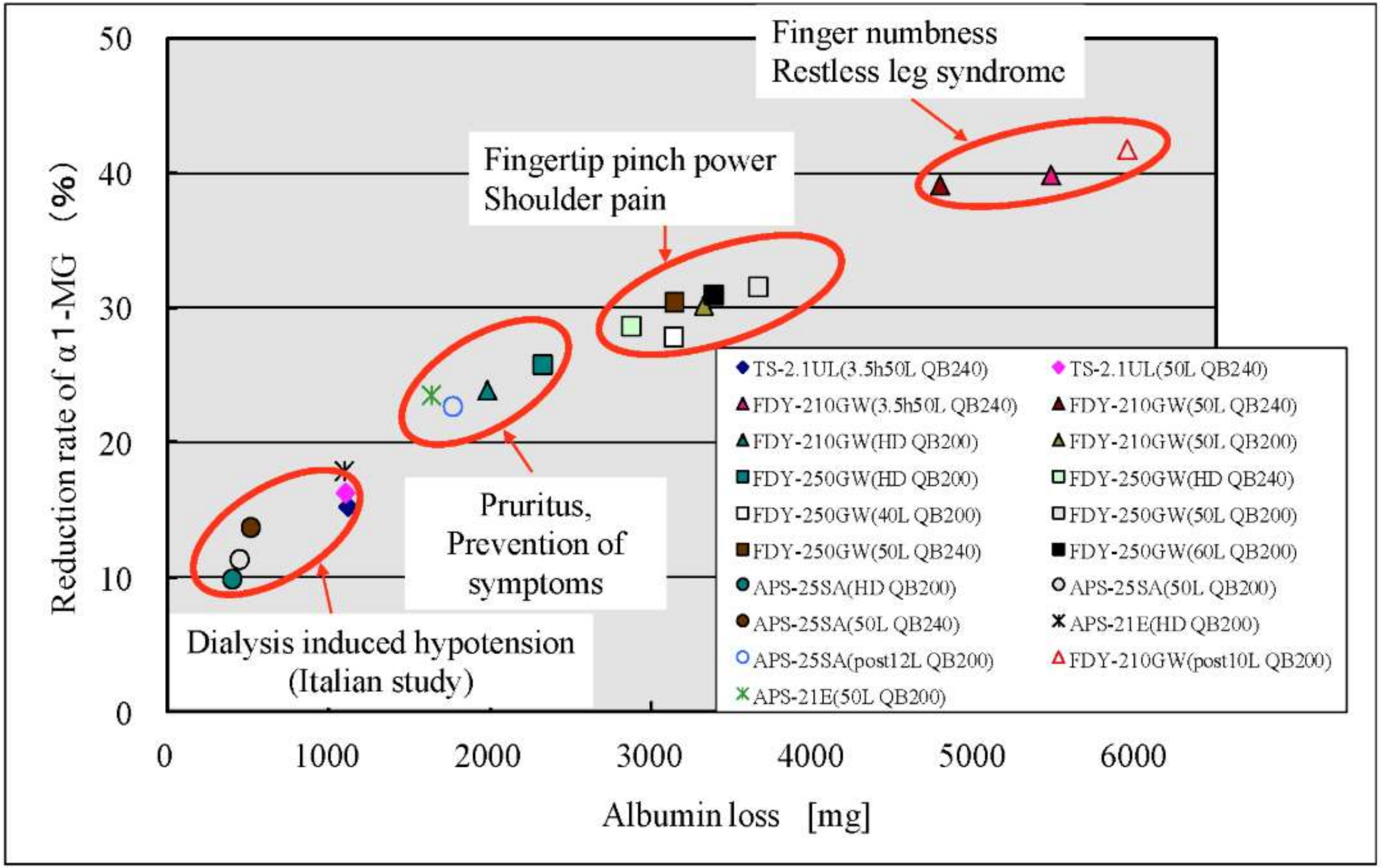
CONCLUSION

In a prospective, sequential, multi-center, open-label clinical trial, the Optiflux dialyzer and the novel dialyzer with Endexo were well tolerated with high URR and spKT/V. The β2-microglobulin removal efficiency was 67% higher with the dialyzer with Endexo.



Endexo - технология

Выведение альфа-1-мг и потери белка



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SHARING EXPERTISE

Hemodialysis International 2018

Review Article

Choosing a dialyzer: What clinicians need to know

Sabrina HAROON[1], Andrew DAVENPORT[2]

[1]*National University Hospital, UCL department of renal medicine and* [2]*UCL Centre for Nephrology, Royal Free Hospital, University College London, London, UK*

Table 1 Definition of terms used to describe a dialyzer

Term	Definition
Flux	Defined as β2 microglobulin clearance[6] 1. Low flux- <10 mL/min 2. Mid flux- 10-20 mL/min 3. High flux >20 mL/min respectively
Bio-incompatibility	Sum of specific interactions between blood and the dialyzer membranes or absence of any perturbations in the blood elements[6,16]
Mass transfer-area coefficient (KoA)	Permeability of the mass transfer barrier between blood and dialysate pathways through diffusion[24]
Hydraulic permeability (KUF)	Intrinsic characteristics of dialyzer that regulate the rate and amount of fluid flow across the dialyzer membrane

Проницаемость

4. Супер хай-флакс

Био-совместимость

Коэффициент массопереноса
При заданой площади мембраны

Гидравлическая проницаемость
(КУФ)

TABLE 4.1 Specifications of Selected Dialyzers and Hemofilters

Manufacturer	Model		Surface Area (m^2)	Membrane	Sterilization	Performance K_{UF} (mL/h per mm Hg)	Performance Urea Cl Q_B = 200 mL/min	Performance Urea Cl Q_B = 300 mL/min	Performance K_0A (mL/min)
ASAHI	PAN	65DX	1.3	Polyacrylonitrile	ETO	29.0	181	231	635
		85DX	1.7	Polyacrylonitrile	ETO	38.0	190	251	839
		110DX	2.2	Polyacrylonitrile	ETO	49.0	193	260	955
	APS	550S	1.1	Polysulfone	Gamma	50.0	180	226	619
		650S	1.3	Polysulfone	Gamma	57.0	186	240	731
		900S	1.8	Polysulfone	Gamma	68.0	192	258	911
		1050S	2.1	Polysulfone	Gamma	75.0	193	261	955
	Rexeed	15R	1.5	Polysulfone	Gamma	63.0	196		1,138
		18R	1.8	Polysulfone	Gamma	71.0	198		1,367
		21R	2.1	Polysulfone	Gamma	74.0	199		1,597
		25R	2.5	Polysulfone	Gamma	80.0	199		1,597
		25S	2.5	Polysulfone	Gamma	80.0	199		1,597
	ViE	13	1.3	Polysulfone-vitamin E	Gamma	37.0	183		670
		15	1.5	Polysulfone-vitamin E	Gamma	40.0	187		755
		18	1.8	Polysulfone-vitamin E	Gamma	43.0	190		839
		21	2.1	Polysulfone-vitamin E	Gamma	45.0	192		911
B BraunAvitum AG	Diacap	LOPS 10	1.0	Polysulfone	Gamma	6.8	176	217	562
		LOPS 10	1.2	Polysulfone	Gamma	7.9	183	233	670
		LOPS 10	1.5	Polysulfone	Gamma	9.8	189	240	809
		LOPS 10	1.8	Polysulfone	Gamma	12.3	192	253	911

J. Daugirdas. Handbook of dialysis,
5-th editon
перевод под ред. В.Ю.Шило

B|BRAUN SHARING EXPERTISE

TABLE 4.1 Specifications of Selected Dialyzers and Hemofilters *(continued)*

Manufacturer	Model		Surface Area (m^2)	Membrane	Sterilization	Performance: K_{UF} (mL/h per mm Hg)	Performance: Urea Cl Q_B = 200 mL/min	Performance: Urea Cl Q_B = 300 mL/min	Performance: K_oA (mL/min)
		LOPS 10	2.0	Polysulfone	Gamma	13.7	194	258	1,005
		HIPS 10	1.0	Polysulfone	Gamma	34.0	180	223	619
		HIPS 12	1.2	Polysulfone	Gamma	42.0	186	238	731
		HIPS 15	1.5	Polysulfone	Gamma	50.0	190	245	839
		HIPS 18	1.8	Polysulfone	Gamma	55.0	192	250	911
		HIPS 20	2.0	Polysulfone	Gamma	58.0	194	253	1,005
	xevonta	Lo 10	1.0	Polysulfone	Gamma	8.0	184	236	680
		Lo 12	1.2	Polysulfone	Gamma	9.0	189	249	812
		Lo 15	1.5	Polysulfone	Gamma	10.0	194	267	1083
		Lo 18	1.8	Polysulfone	Gamma	12.0	196	276	1292
		Lo 20	2.0	Polysulfone	Gamma	14.0	198	281	1450
		Lo 23	2.3	Polysulfone	Gamma	15.0	199	285	1614
		Hi 10	1.0	Polysulfone	Gamma	58.0	186	241	847
		Hi 12	1.2	Polysulfone	Gamma	69.0	191	255	1003
		Hi 15	1.5	Polysulfone	Gamma	87.0	197	272	1312
		Hi 18	1.8	Polysulfone	Gamma	99.0	198	281	1536
		Hi 20	2.0	Polysulfone	Gamma	111.0	199	287	1725
BAXTER	PSN	120	1.2	Polysynthane	ETO	6.7	180	228	619
		140	1.4	Polysynthane	ETO	7.6	184	237	689
	CA	110	1.1	Cellulose acetate	ETO or Gamma	5.3	176	215	562

Xevonta 23 1900

J. Daugirdas. Handbook of dialysis, 5-th editon
перевод под ред. В.Ю.Шило

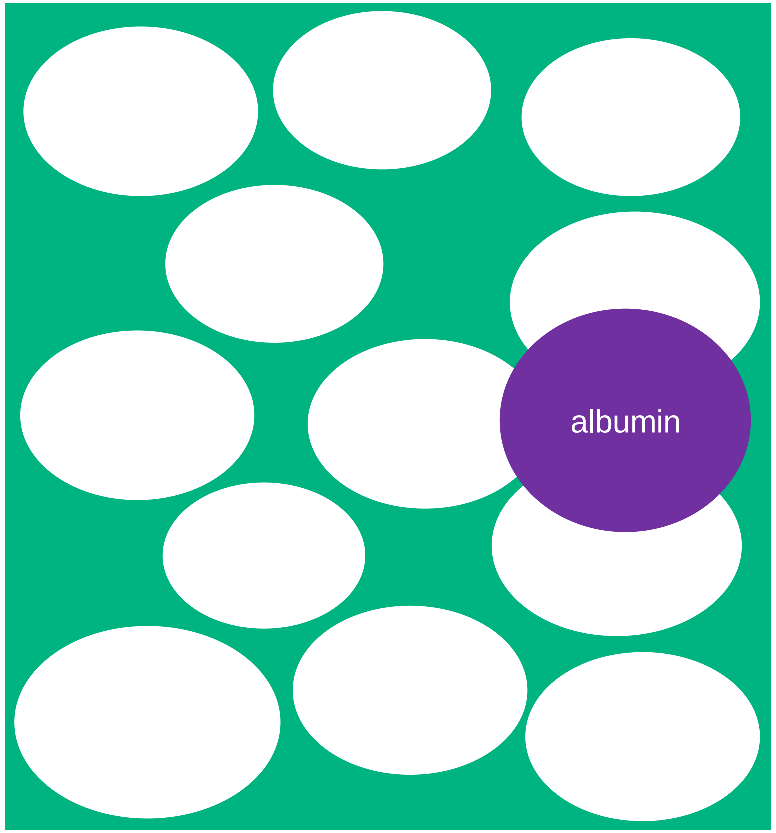
КОНЦЕПЦИЯ ПРОНИЦАЕМОСТИ/СЕЛЕКТИВНОСТИ

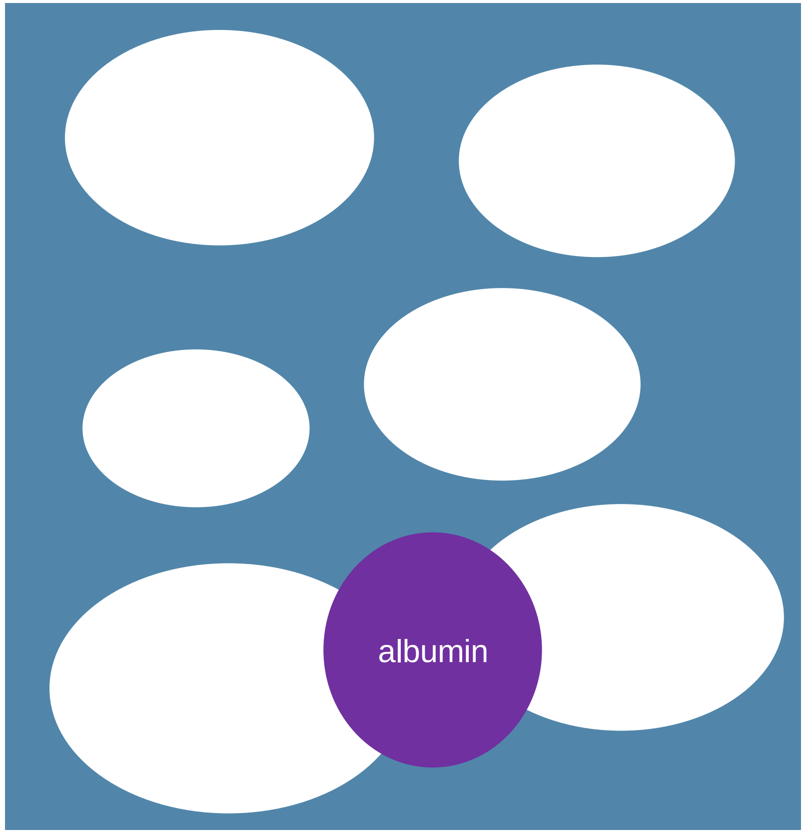
ВАЖНА ЛИ ТАКЖЕ ГИДРАВЛИЧЕСКАЯ ПРОНИЦАЕМОСТЬ?

The membrane permeability depends on 3 factors: :

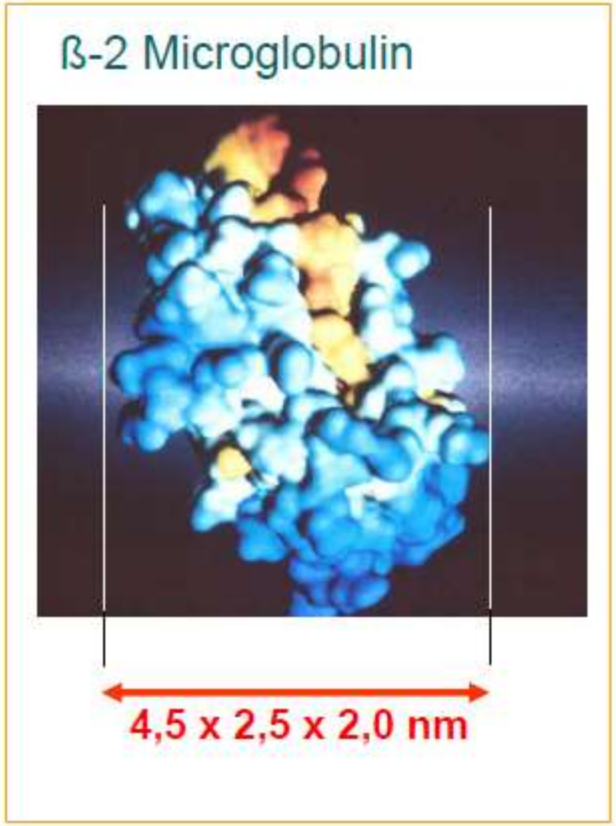
1. The number of pores
2. The size of pores
3. The variance in pore size

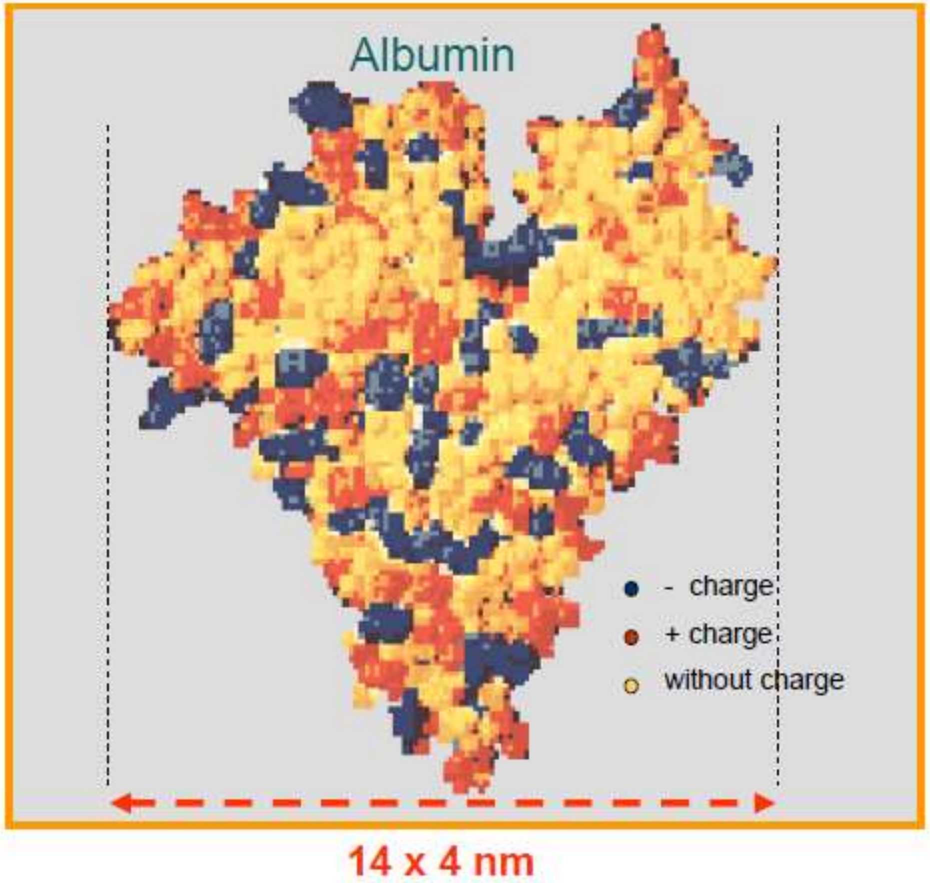
The overall permeability depends on the accumulated area of all pores (total open area)





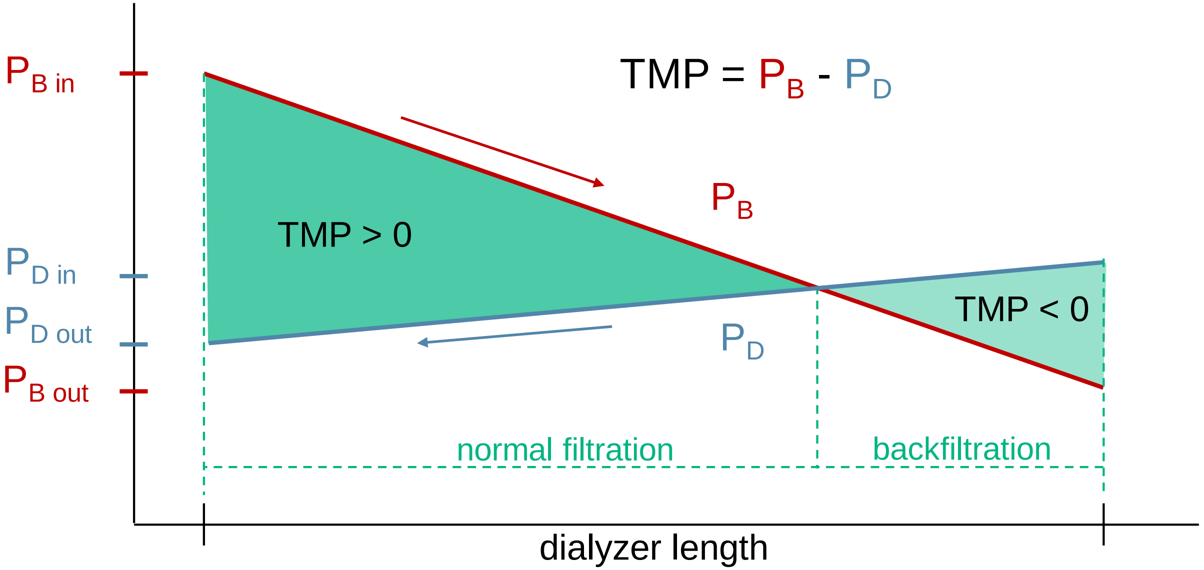
Белки крови и их размеры





2795-2

ОБРАТНАЯ ФИЛЬТРАЦИЯ
КАК ЭТО РАБОТАЕТ



P_B: pressure blood side
P_D: pressure dialysate side

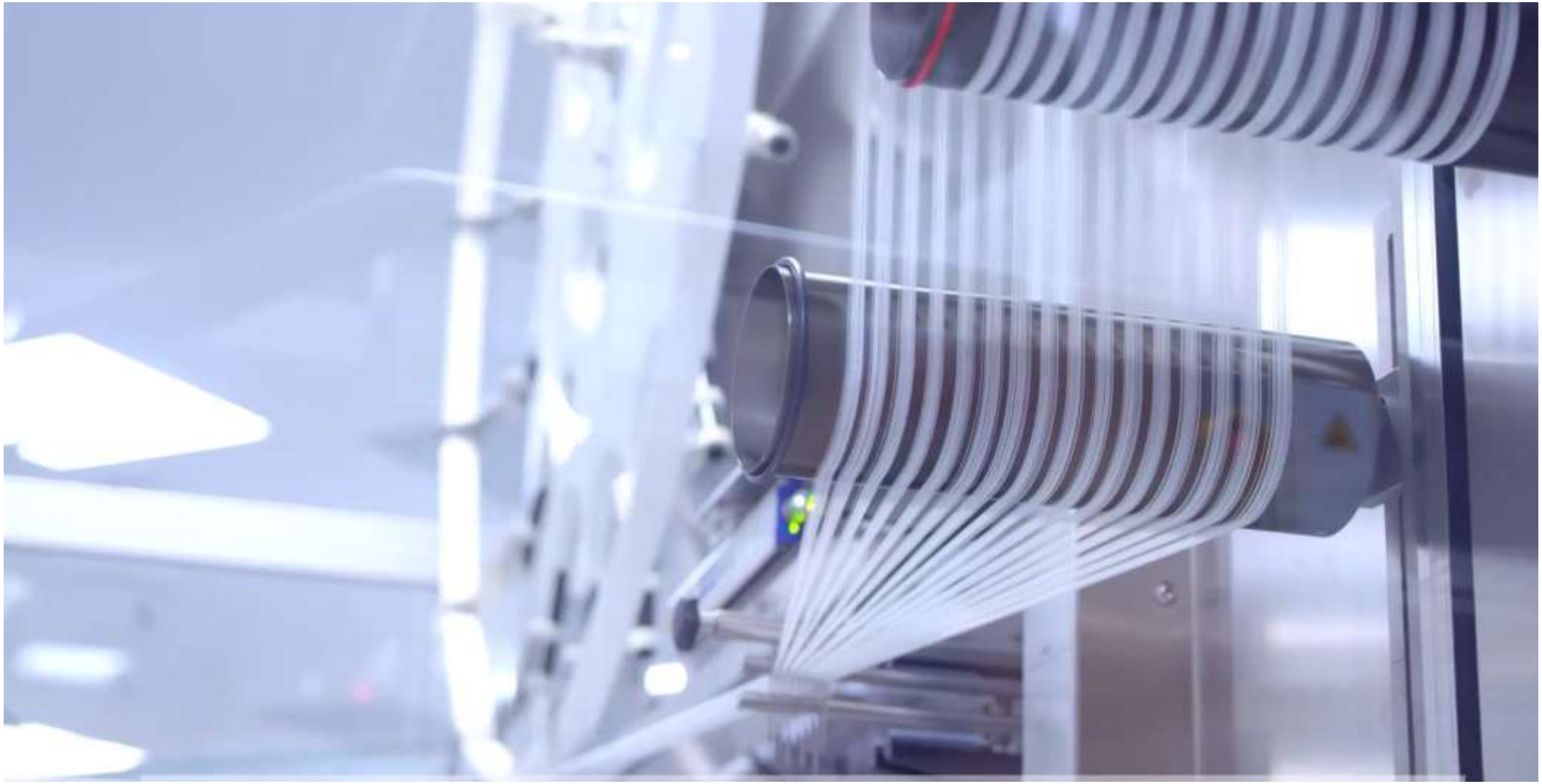
TMP: trans membrane pressure

The pressure inside a dialyzer is always higher at the blood inlet compared to the blood outlet. The same is true for the dialysate inlet and outlet.

In high flux dialyzers at some point the pressure curves of dialysate and blood side cross each other, which means that the TMP gets negative. This allows dialysate to move from the dialysate to the blood (backfiltration).

Via the balance chamber the dialysis machine automatically recognizes this and increases the normal filtration in order to balance the in and outgoing fluid.

This way normal filtration volume is increased, which increases the relevance of convection versus diffusion.



B|BRAUN
SHARING EXPERTISE

xevonta
ЭТАЛОН ВЫСОКОПРОНИЦАЕМОГО ПРЕМИАЛЬНОГО ДИАЛИЗАТОРА

Высокая проницаемость и КУФ

- The unique design of the xevonta membrane *amembris* ensures the best water permeability amongst all high flux dialyzers. [2]
- This makes xevonta an expert in convective therapies like HDF

Баланс между выведением токсинов и сохранением альбумина

- The elimination of uremic toxins (such as urea and phosphate) has been increased significantly. [1]
- In addition the high permeability enables a high removal of middle molecules
- Despite high permeability and toxin removal, albumin loss is substantially minimalized (~1 g / HDF-therapy with xevonta Hi 23).[3]

Diacap Pro
УНИКАЛЬНЫЙ ПРОДУКТ

Экономит время на общение с пациентов

Diacap Pro is the reliable partner in managing your day-to-day needs by combining efficient performance and user-friendly handling.

Удобен в использовании

- Efficient air removal with only up to 300 ml of priming volume helps to reduce cost and time.
- Easy-to-open packaging and improved plugs help staff to easily prepare and perform treatment.

Обеспечивает высокую эффективность

- Improved *α-Polysulfone Pro* membrane provides high uremic toxin elimination.
- The high permeability enables patients to efficiently achieve their HD targets.

Diacap Pro
УНИКАЛЬНЫЙ ПРОДУКТ

① OPENING IDENTIFICATION

easy to identify opening mechanism

② THUMB SLOT

easy to separate layers

③ ANGLED SEALING

little force needed for opening

Diacap Pro
УНИКАЛЬНЫЙ ПРОДУКТ

On the backside of each dialyzer

УДАЛЯЕМАЯ 2ND ЭТИКЕТКА
Easy protocol documentation

- Самоклеящаяся
- Ничего не нужно переписывать вручную

B. BRAUN ДИЗАЙН ЭТИКЕТКИ
Important information at one glance

- Product
- Surface
- Flux
- Extracorporal volume
- Expiry date
- …

МАТРИКСНЫЙ КОД
Relevant data encoded in UDI

- On box & product label
- Product name
- Article code
- Batch number
- Expiry date
- …

Diacap Pro
УНИКАЛЬНЫЙ ПРОДУКТ

ANGELED BLOOD CAPS
Efficient air removal

- Angle enables air to easily travel upwards

RELIABLE PROTECTION CAPS
Easy to open, easy to close

- Protected blood side
- No leakages in preparation

CRISTAL CLEAR HOUSING
Knowing what is going on inside

- Strong and durable housing
- Transparent blood cap
- Quickly discover trapped air
- Easily identify early clotting

Diacap Pro
УНИКАЛЬНЫЙ ПРОДУКТ

B|BRAUN
SHARING EXPERTISE

ВЫСОКАЯ ПЛОТНОСТЬ ВОЛОКОН
Больше волокон в меньшем объеме

- Consistent dialysate flow distribution
- Faster dialysate flow
- Less air trapped

No losses in performance

→ Avoiding membrane clustering

ВОЛНИСТОСТЬ ВОЛОКНА
Улучшение потока крови и омывания волокна

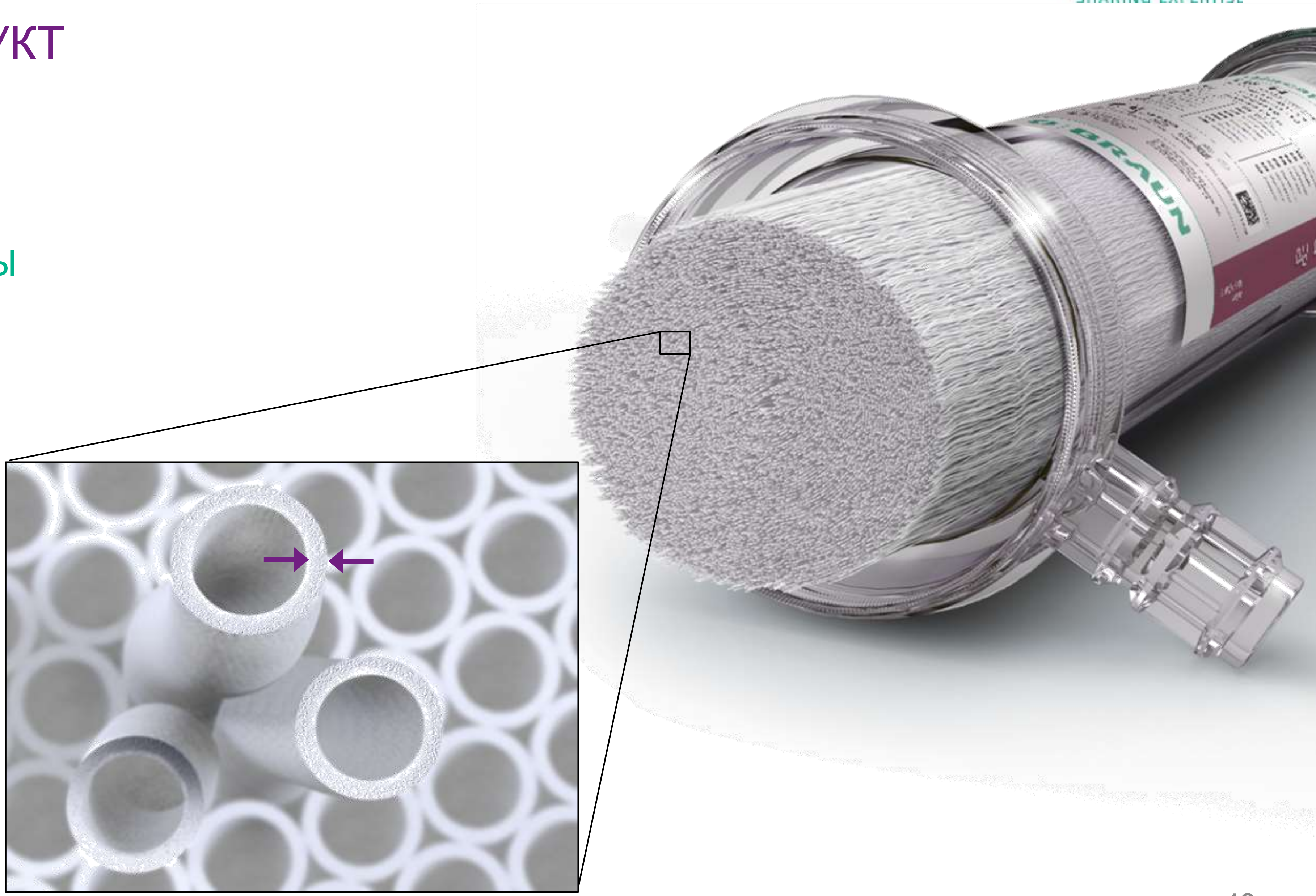
- Mixing the blood while flowing
- Increasing diffusive behavior

Diacap Pro
УНИКАЛЬНЫЙ ПРОДУКТ

УМЕНЬШЕНИЕ ТОЛЩИНЫ СТЕНКИ КАПИЛЛЯРА

Улучшение диффузии

- Shorter ways
- More efficient removal



Diacap Pro

УНИКАЛЬНЫЙ ПРОДУКТ
ПРЕМИАЛЬНЫЙ ДИАЛИЗАТОР ПО ДОСТУПНОЙ ЦЕНЕ

2 МЕСТО ПО ГИДРАВЛИЧЕСКОЙ ПРОНИЦАЕМОСТИ

Увеличивает конвекцию

- Higher convection, also in HD
- High volume HDF possible
- Reduced complication rate
- Efficiently achieve HD targets
- Also for overloaded patients

НИЗКИЕ ПОТЕРИ АЛЬБУМИНА

Бескомпромиссная безопасность

- Despite high convection
- SC for albumin below 0,001

DIACAP PRO
УНИКАЛЬНЫЙ ПРОДУКТ

B|BRAUN SHARING EXPERTISE

Diacap Pro high flux
PERFORMANCE DATA

		Pro 13H			Pro 16H			Pro 19H		
Blood flow (Q_B) ml/min		200	300	400	200	300	400	200	300	400
Clearance Dialysate flow = 500 ml/min Ultrafiltration flow (Q_F) = 0 ml/min	Urea	194	263	303	196	270	322	197	280	332
	Creatinine	185	236	269	189	248	284	194	260	305
	Phosphate	178	220	249	184	230	261	186	242	278
	Vitamin B_{12}	133	151	167	143	166	183	150	180	202
	Inulin	86	92	101	96	106	116	102	117	128
	Cytochrome C	65	73	75	72	81	86	80	90	95
S. C. (Sieving Coefficient) Q_B = 300 ml/min Q_F = 60 ml/min	Inulin					1.0				
	β_2-microglobulin					0.7				
	Albumin					< 0.001				
Ultrafiltration coefficient (ml/h/mmHg)			70			85			97	
KoA urea (Q_B = 300 ml/min)			1010			1145			1415	

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ЗАКЛЮЧЕНИЕ
МИР ДИАЛИЗНЫХ МЕМБРАН

B|BRAUN SHARING EXPERTISE

- Биосовместимые полимерные мембраны лоу-флакс по-прежнему востребованы у отдельных категорий больных
- Нет проблем с удалением малых молекул, за исключением мембран низкого качества
- Все больше научных данных за использование мембран хай-флакс и ГДФ он-лайн (обязательное условие – ультрачистый диализат!!!)
- Мембраны хай флакс завоевали мир (доля свыше 80%)
- Коэффициент просеивания для средних молекул и клиренс бета-2-МГ становятся важными компонентами выбора мембраны хай-флакс
- Высокий КУФ необходим для достижения целевого конвекционного объема
- Высокопроницаемые селективные мембраны диализаторов Ксевонта и Диакап-Про обеспечивают удобство и наиболее широкий спектр применения (ХФГД с большим объемом внутренней фильтрации, ГДФ- онлайн с высоким конвекционным объемом), при этом минимизируя потери альбумина.

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and learn more at

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