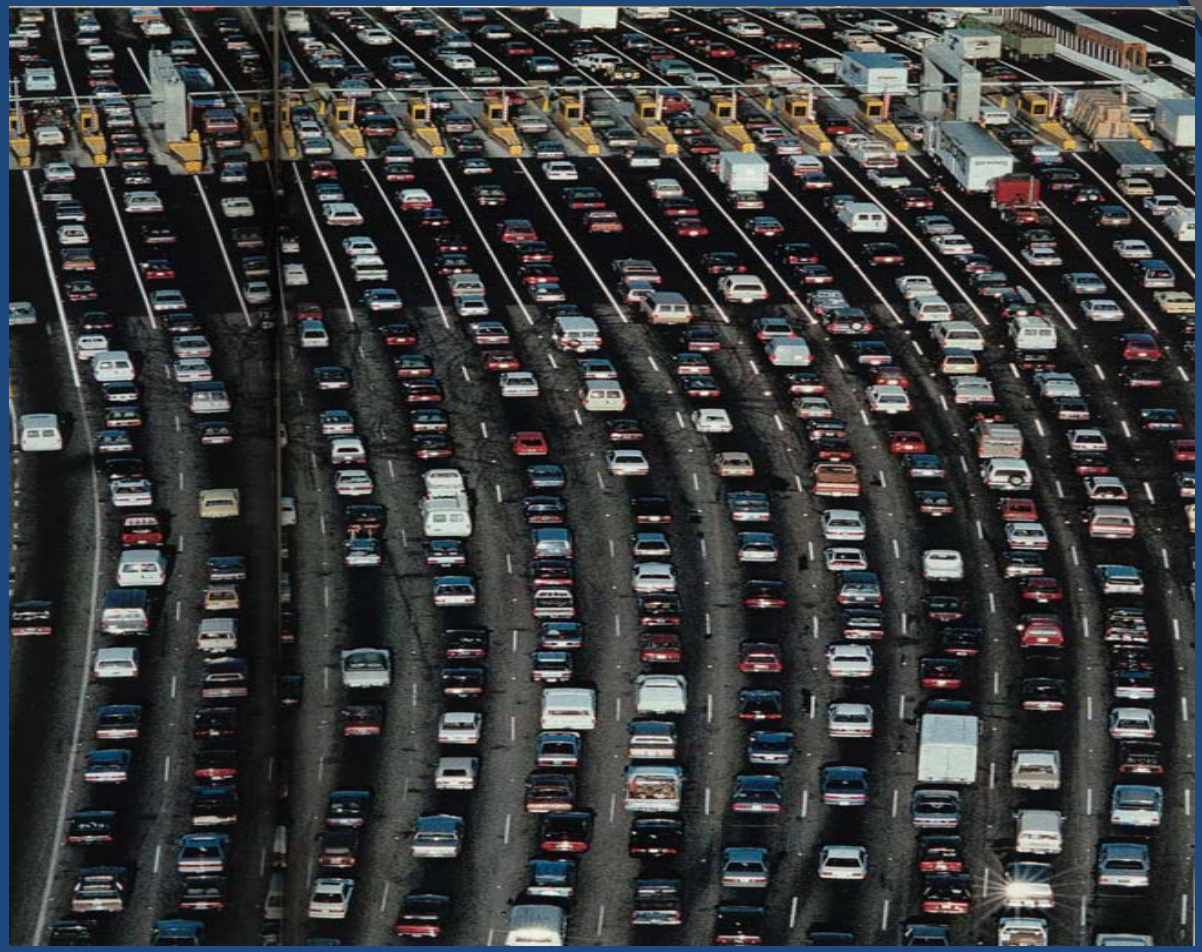
VÜCUTTA TAŞINABİLİR DİYALİZ MAKİNALARI DİYALİZ PRATİĞİNİ NASIL ETKİLEYECEK?

Dr. Aykut SİFİL
Dokuz Eylül Üniversitesi



Bazı insanlar olanları görür ve sorgular,
bazı insanlar ise olmayan şeyleri hayal eder ve neden olmasın der George Bernard Shaw

- Harold R. Ridley 1949
- Sir Harold R. Ridley 1952
- Diyaliz makinaları küçültülerek vücuda takılabilir mi?

  1994 bir tıp fakültesi öğrencisi
- Daha gerçekçi şeylerle uğraşmak lazım

  Aykut Sifil

- 640 KB bellek herkes için yeterli olacaktır

  Bill Gates
- Dünya piyasası 5 bilgisayardan fazlasını kaldıramaz.

  IBM Başkanı Thomas Watson - 1943

- Şimdiye kadar icat edilebilecek her şey icat edilmiştir.

  Charles Duell A.B.D. patent dairesi yetkilisi – 1899

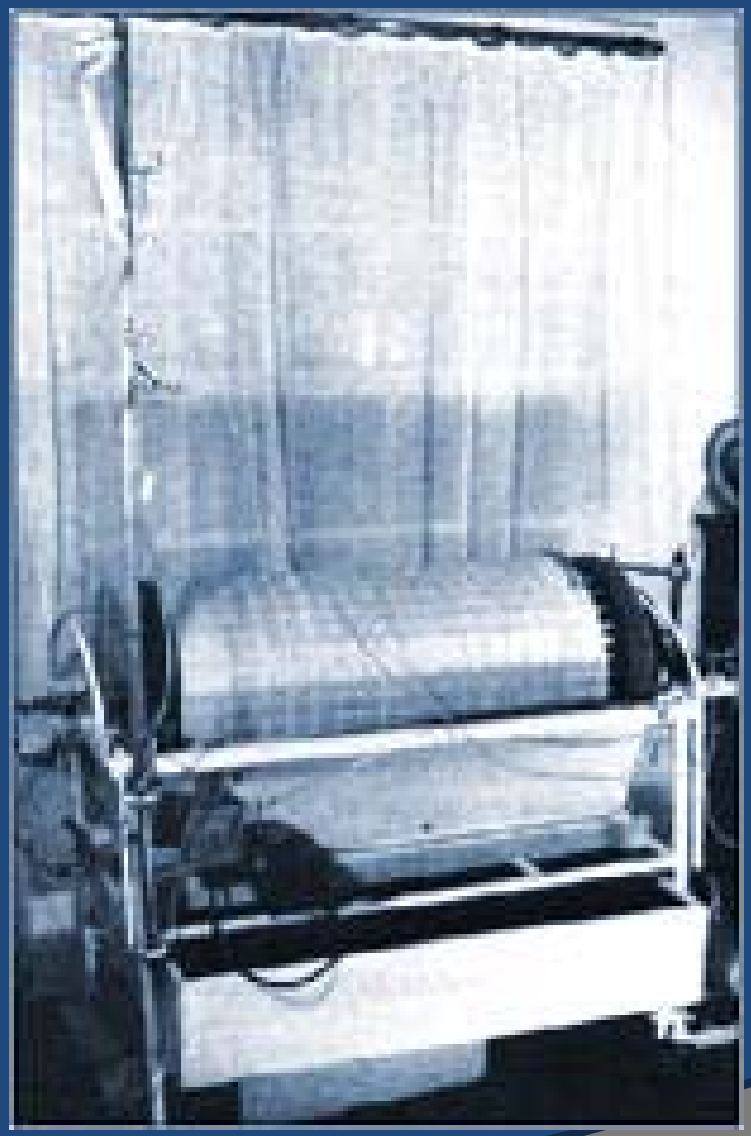
- Atlar her zaman kullanılacaktır.Otomobil ise ancak geçici bir moda olabilir.

  1903 banka müdürü

- İmkansızı hayal eden insanlara ihtiyacımız var.

John F. Kennedy

Willem Kolff

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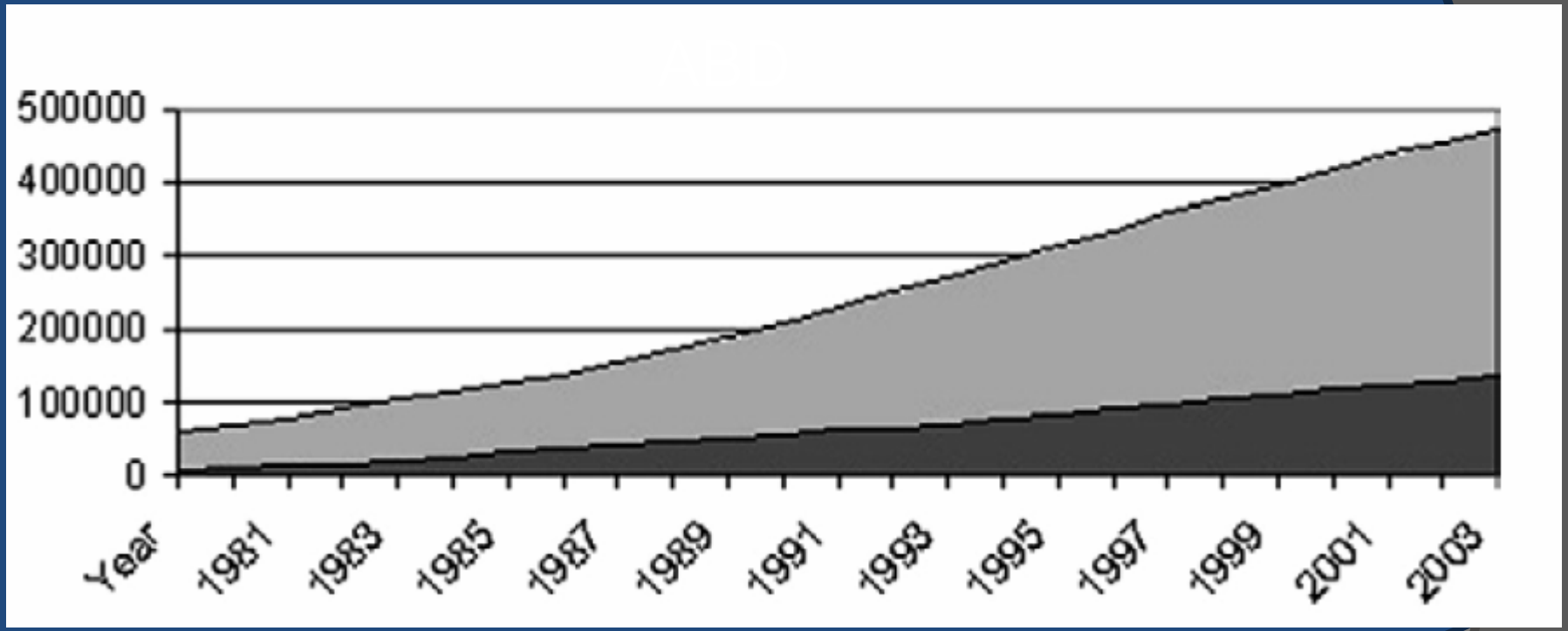
DİYALİZ HASTA SAYISI



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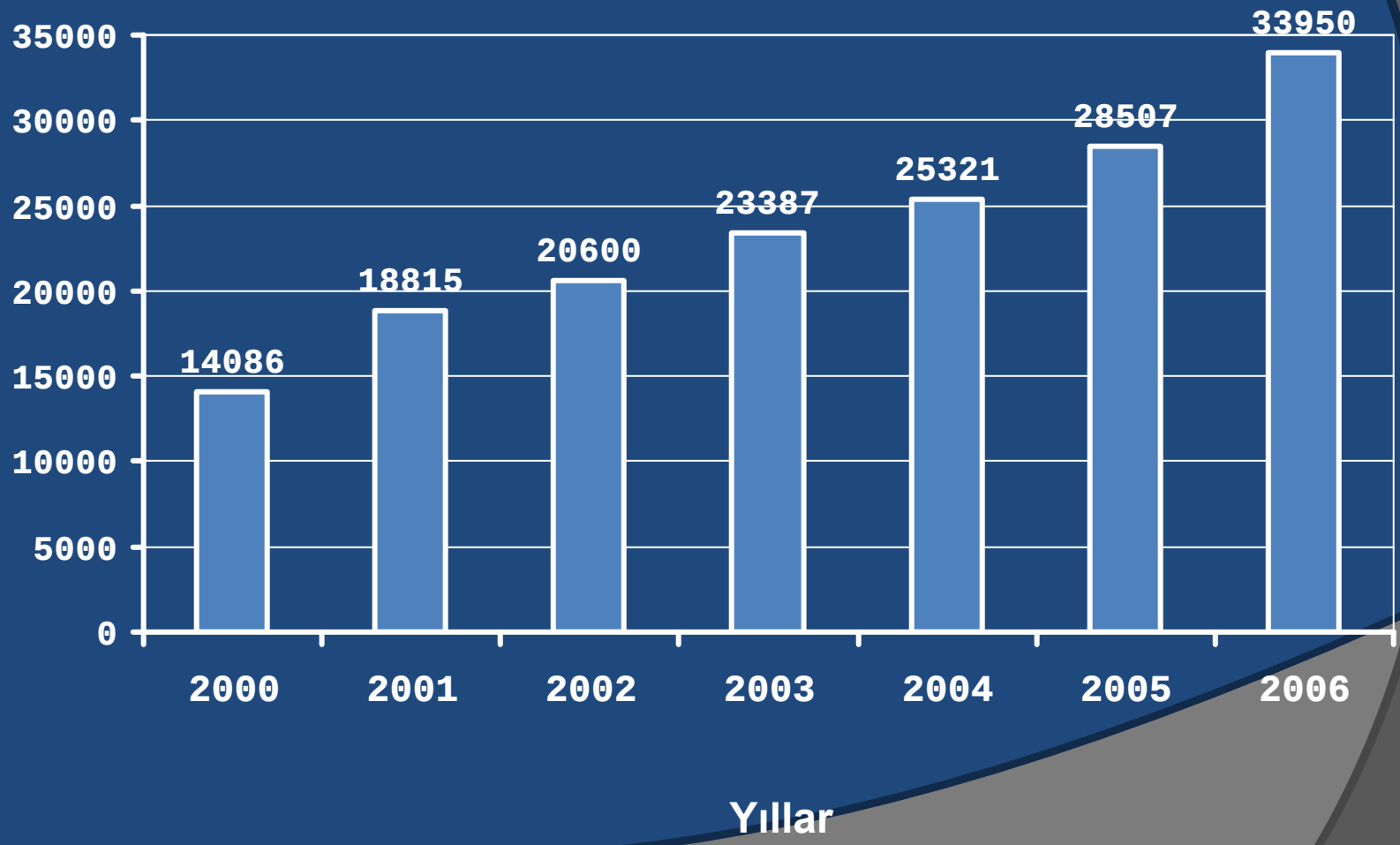
Yıllara Göre HD Hasta Sayıları



DİYALİZİN KISITLARI

- Ölüm-hasta olma oranı yüksek
- Fizyolojik değil
- Hasta yaşam kalitesi düşük
- Pahalı

DİYALİZ VİZYONU

- Taşınabilir makinalar
- Membrandaki yenilikler

A wearable haemodialysis device for patients with end-stage renal failure: a pilot study

Andrew Davenport, Victor Gura, Claudio Ronco, Masoud Beizai, Carlos Ezon, Edmond Rambod

Summary

Background More frequent haemodialysis can improve both survival and quality of life of patients with chronic kidney disease. However, there is little capacity in the UK to allow patients to have more frequent haemodialysis treatments in hospital and satellite haemodialysis units. New means of delivering haemodialysis are therefore required. Our aim was to assess the safety and efficiency of a wearable haemodialysis device.

Methods Eight patients with end-stage kidney failure (five men, three women, mean age 51·7 [SD 13·8] years) who were established on regular haemodialysis were fitted with a wearable haemodialysis device for 4–8 h. Patients were given unfractionated heparin for anticoagulation, as they would be for standard haemodialysis.

Findings There were no important cardiovascular changes and no adverse changes in serum electrolytes or acid-base balance. There was no evidence of clinically significant haemolysis in any patient. Mean blood flow was 58·6 (SD 11·7) mL/min, with a dialysate flow of 47·1 (7·8) mL/min. The mean plasma urea clearance rate was 22·7 (5·2) mL/min and the mean plasma creatinine clearance rate was 20·7 (4·8) mL/min. Clotting of the vascular access occurred in two patients when the dose of heparin was decreased and the partial thromboplastin time returned towards the normal reference range in both of these patients. The fistula needle became dislodged in one patient, but safety mechanisms prevented blood loss, the needle was replaced, and treatment continued.

Interpretation This wearable haemodialysis device shows promising safety and efficacy results, although further studies will be necessary to confirm these results.

Lancet 2007; 370: 2005–10

See Comment page 1977

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Introduction

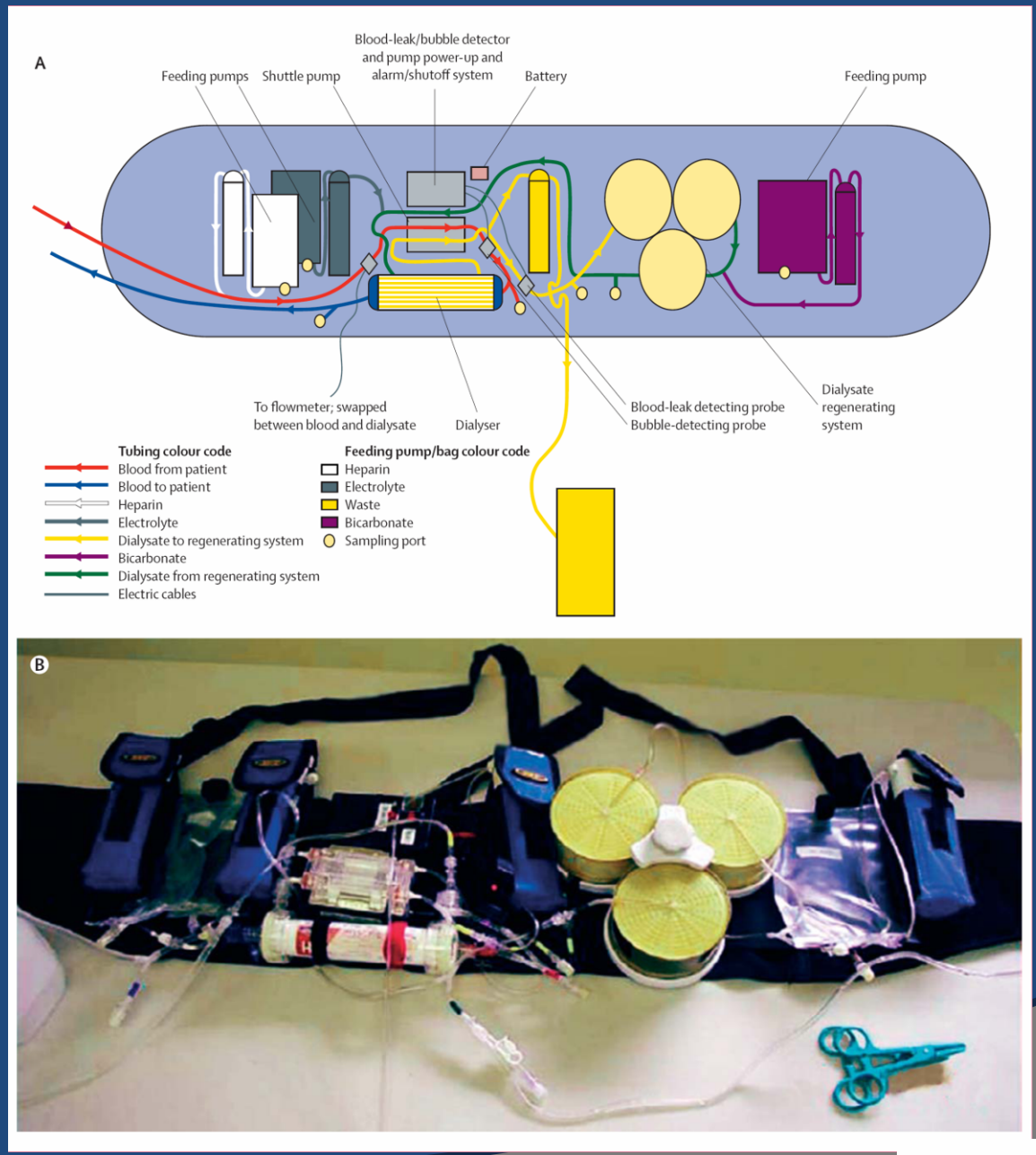
Nearly 1 300 000 patients worldwide have chronic kidney failure that requires treatment with either dialysis or renal transplantation. Despite haemodialysis being an estab-

Methods

Patients

Eight patients with established chronic kidney disease treated by regular haemodialysis three times a week

Lancet 2007; 370: 2005–10



Lancet 2007; 370: 2005–10

	Treatment time (h)	Weight (kg)		Extracellular fluid/total body fluid		Urea removed (mmol)	Creatinine removed (mmol)	Plasma urea clearance (mL/min)	Plasma creatinine clearance (mL/min)	Standard hourly urea clearance (Kt/V)
		Before treatment	After treatment	Before treatment	After treatment					
Patient 1	4	81·6	80·7	0·342	0·339	6·2	5·4	15·2	12·6	0·02
Patient 2	4	59·7	59·3	0·343	0·337	9·1	5·4	31·6	28·0	0·05
Patient 3	4	56·4	55·5	0·345	0·342	5·7	3·6	22·8	18·0	0·03
Patient 4	7	62·6	62·3	0·324	0·319	7·0	5·4	19·5	19·9	0·03
Patient 5	8	56·5	56·9	0·344	0·343	14·0	15·2	26·8	25·9	0·04
Patient 6	8	88·5	86·7	0·327	0·320	15·5	8·9	25·4	24·1	0·05
Patient 7	8	117·3	115·8	0·352	0·350	18·0	13·4	21·3	20·1	0·02
Patient 8	8	48·0	46·6	0·337	0·335	6·7	4·5	18·4	16·9	0·04
Mean (SD)	6·4 (2·0)	71·3 (23)	70·5 (22·6)	0·339 (0·009)	0·335 (0·010)	10·3 (4·8)	7·7 (4·4)	22·7 (5·2)	20·7 (4·8)	0·035 (0·01)

Table 1: Characteristics of patients

Lancet 2007; 370: 2005–10

	Time (h)				
	Before	2	4	6	8
Serum electrolytes					
Na (mmol/L)	133 (2·7)	134 (1·5)	135 (1·9)	135 (2·0)	135 (2·6)
K (mmol/L)	4·2 (0·3)	4·4 (0·5)	4·1 (0·3)	4·1 (0·5)	4·1 (0·5)
iCa (mmol/L)	1·1 (0·9)	1·11 (0·1)	1·13 (0·1)	1·14 (0·1)	1·11 (0·1)
Acid-base balance					
pH	7·35 (0·1)	7·35 (0·06)	7·35 (0·07)	7·33 (0·05)	7·36(0·05)
Bicarbonate (mmol/L)	24·9 (3·7)	23·3 (3·2)	22·2 (2·8)	22·1 (2·4)	22·0 (3·3)
Markers of haemolysis					
Haematocrit (%)	0·358(0·03)	0·34 (0·04)	0·358(0·03)	0·345(0·04)	0·35(0·04)
Serum haptoglobin (g/L)	1·29 (0·8)	1·39 (0·7)	1·20 (0·8)	0·80 (0·5)	0·85 (0·5)
LDH (U/L)	307 (145)	345 (146)	381 (93)	240 (149)	353 (39)
Cardiovascular measurements					
SBP (mm Hg)	139 (28)	138 (29)	137 (25)	142 (30)	153 (12·5)*
DBP (mm Hg)	86 (20)	85 (17)	85 (18)	85 (19)	96 (13)*
Heart rate (bpm)	66 (12)	64 (9)	67 (10)	66 (6)	70 (10)

Data are mean (SD). DBP=diastolic blood pressure. iCa=serum ionised calcium. K=serum potassium. LDH=lactate dehydrogense. Na=serum sodium. SBP=systolic blood pressure. *One patient, with an SBP of about 80 mm Hg, did not contribute to 8 h blood pressure measurements because of circuit clotting.

Table 2: **Electrolyte, acid-base changes, and markers of haemolysis and cardiovascular stability**

Lancet 2007; 370: 2005–10

The Vicenza Wearable Artificial Kidney for Peritoneal Dialysis (ViWAK PD)

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Key Words

Vicenza wearable artificial kidney for peritoneal dialysis · ViWAK PD · Wearable CAPD system

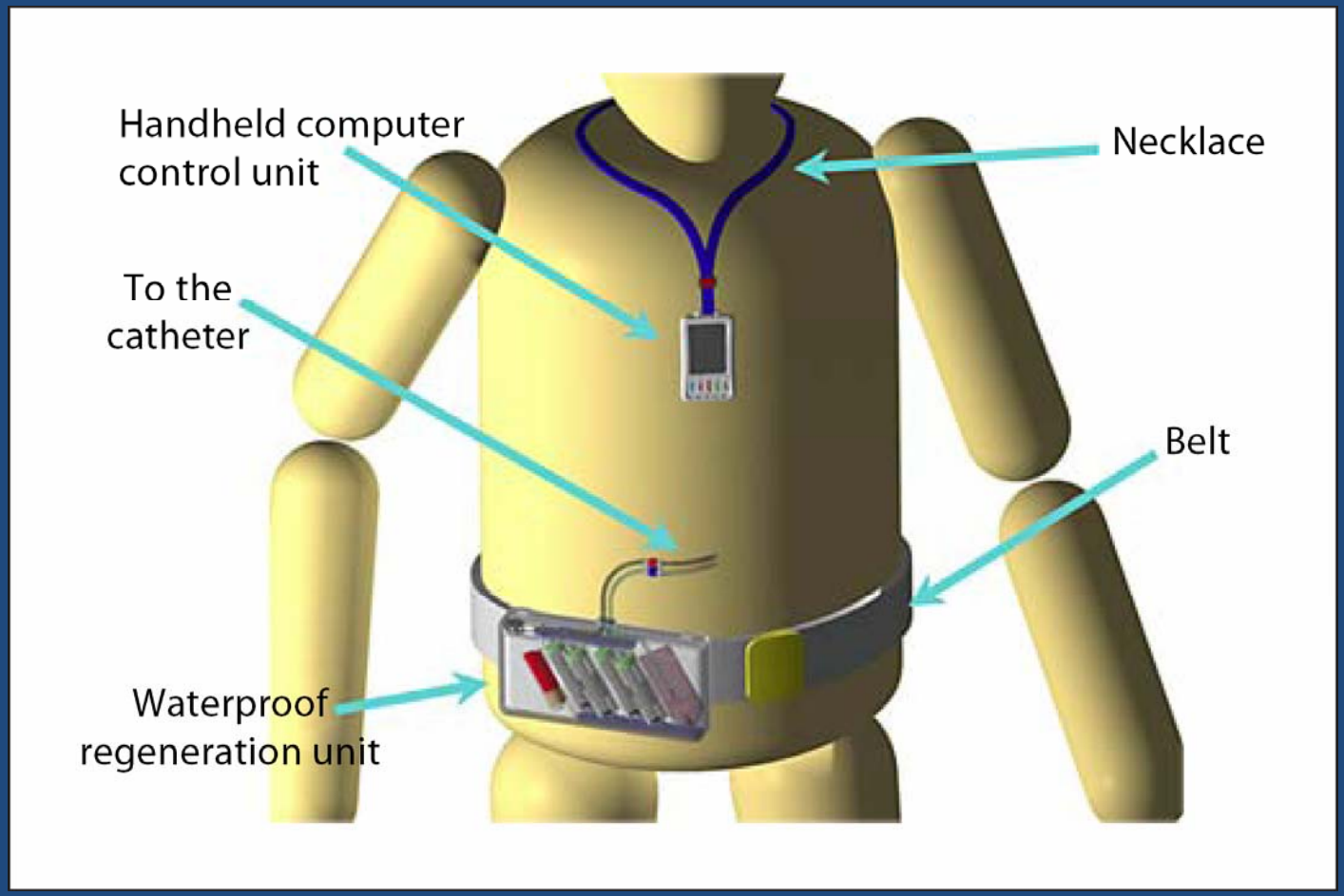
Abstract

Background: The study describes the structure and operational characteristics of a new wearable system for continuous ambulatory peritoneal dialysis (CAPD) for chronic kidney disease patients. ***Methods:*** We designed a wearable system consisting of: (1) a double lumen peritoneal catheter; (2) a dialysate outflow line; (3) a miniaturized rotary pump; (4) a circuit for dialysate regeneration featuring a waterproof container with 4 cartridges in parallel with a mixture of activated carbon and polystyrenic resins; (5) a filter for deaeration and microbiological safety; (6) a dialysate inflow line, and (7) a handheld computer as a remote control. The system has been tested circulating 12 liters of exhausted PD solution through the experimental adsorption unit at a rate of 20 ml/min. Creatinine, β_2-microglobulin (β_2-MG) and angiogenin were measured before and after the adsorption unit at baseline, and after 4 and 10 h of use. ***Results:*** The cartridges containing polystyrenic resin completely removed β_2-MG and angiogenin from the fluid batch. Those with the activated carbon removed completely urea and creatinine. The final result was 11.2 liters of net solute clearance. The system is designed to be used as follows: The peritoneal cavity is loaded in the morning with 2 liters of fresh PD solution. After 2 h, when dialysate/plasma equilibration at approximately 50% has occurred, recirculation is activated for 10 h at a rate of 20 ml/min. After this period, recirculation stops and glucose is optionally added to the peritoneal cavity to achieve ultrafiltration if needed. After 2 h the fluid is drained and a 2-liter icodextrin exchange is performed overnight to achieve further ultrafiltration. The clearance provided by the minicycler is further increased by the 2-liter exchange and the overnight exchange. Therefore, the system operates 24 h/day and provides creatinine and β_2-MG clearance in the range of 15–16 liters/day, corresponding to a weekly clearance of 100–110 liters. The patient reduces the number of exchanges compared to CAPD and uses less fluid than in automated peritoneal dialysis (APD). Furthermore, the handheld computer allows for prescription and assessment of the therapy providing information on cartridge saturation, flow and pressure conditions and offering the possibility of remote wireless control of operations. Some problems still remain to be solved in the present configuration including the addition of an injection system for glucose and bicarbonate when needed, a system to reduce fibrin delivery to the sorbent and finally a more complex mixture of sorbents to make sure a complete removal of small molecules including urea is achieved. ***Conclusion:*** The wearable PD system may become a possible alternative to APD or CAPD reducing the time dedicated to perform exchanges and improving peritoneal dialysis adequacy and patient's rehabilitation.

Introduction

The increased incidence of chronic kidney disease and the parallel increase of the prevalence of patients treated with renal replacement therapy are considered an important factor in the future allocation of national budgets for

Blood Purif 2007;25:383–388



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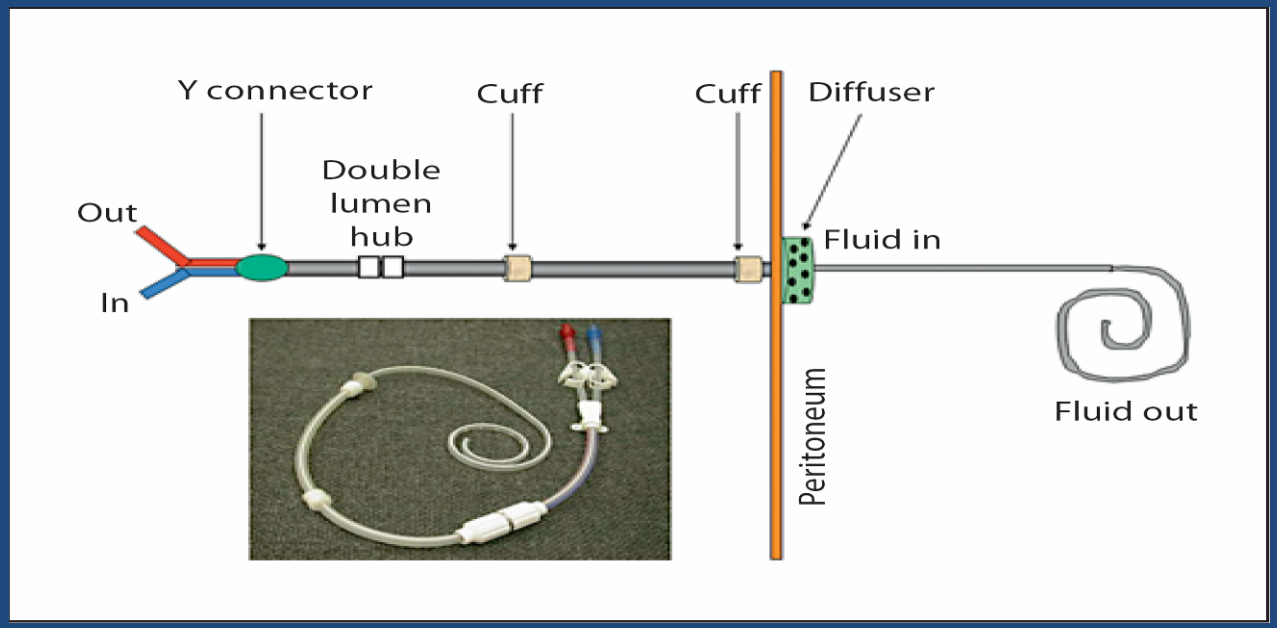

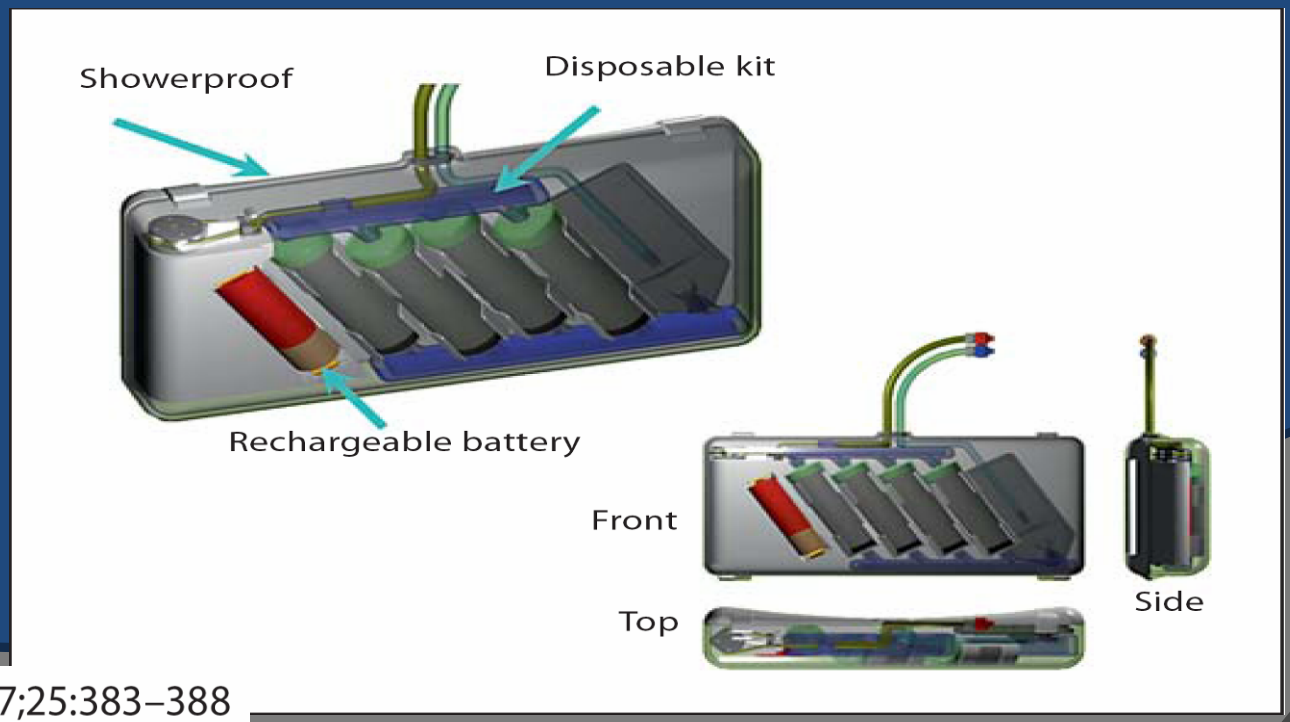

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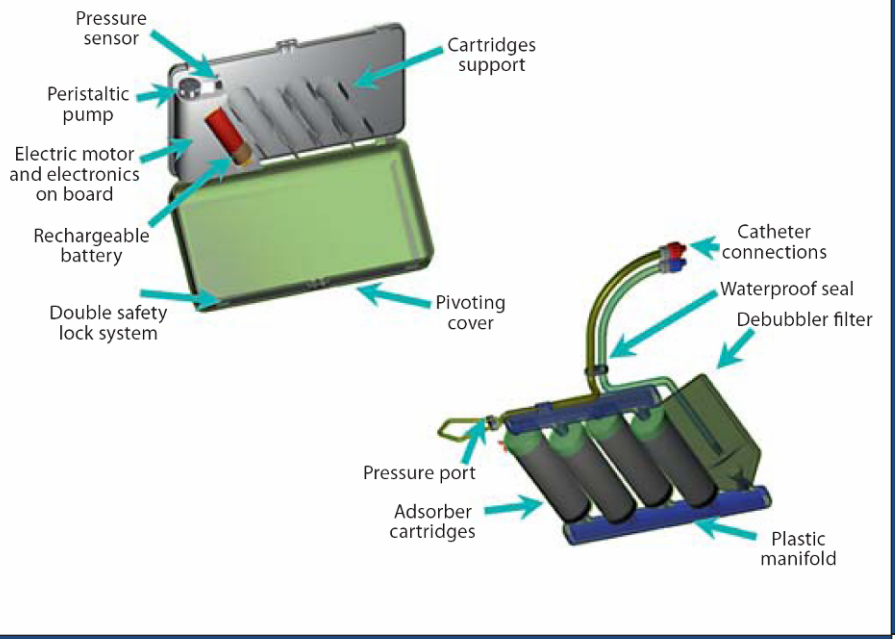

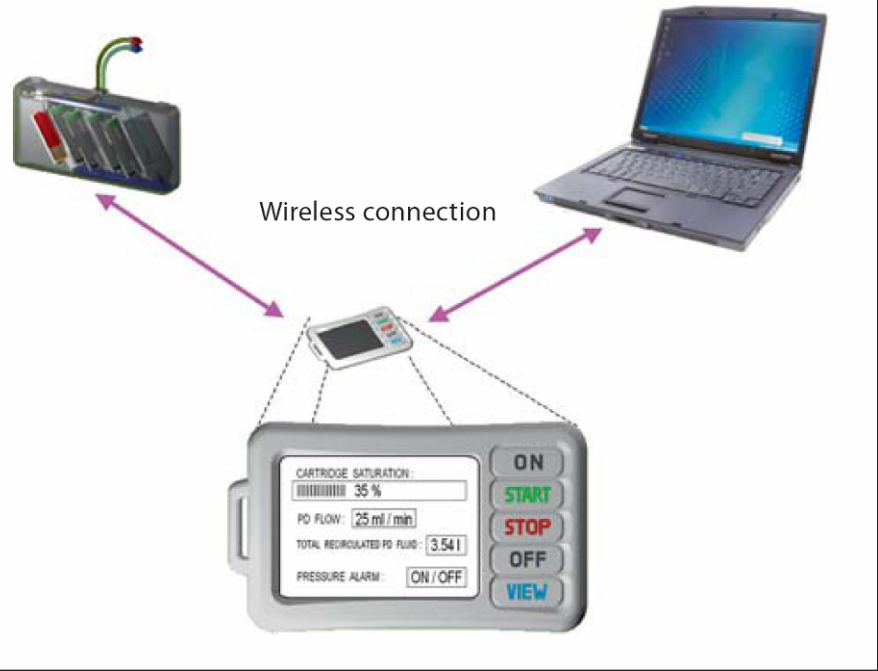

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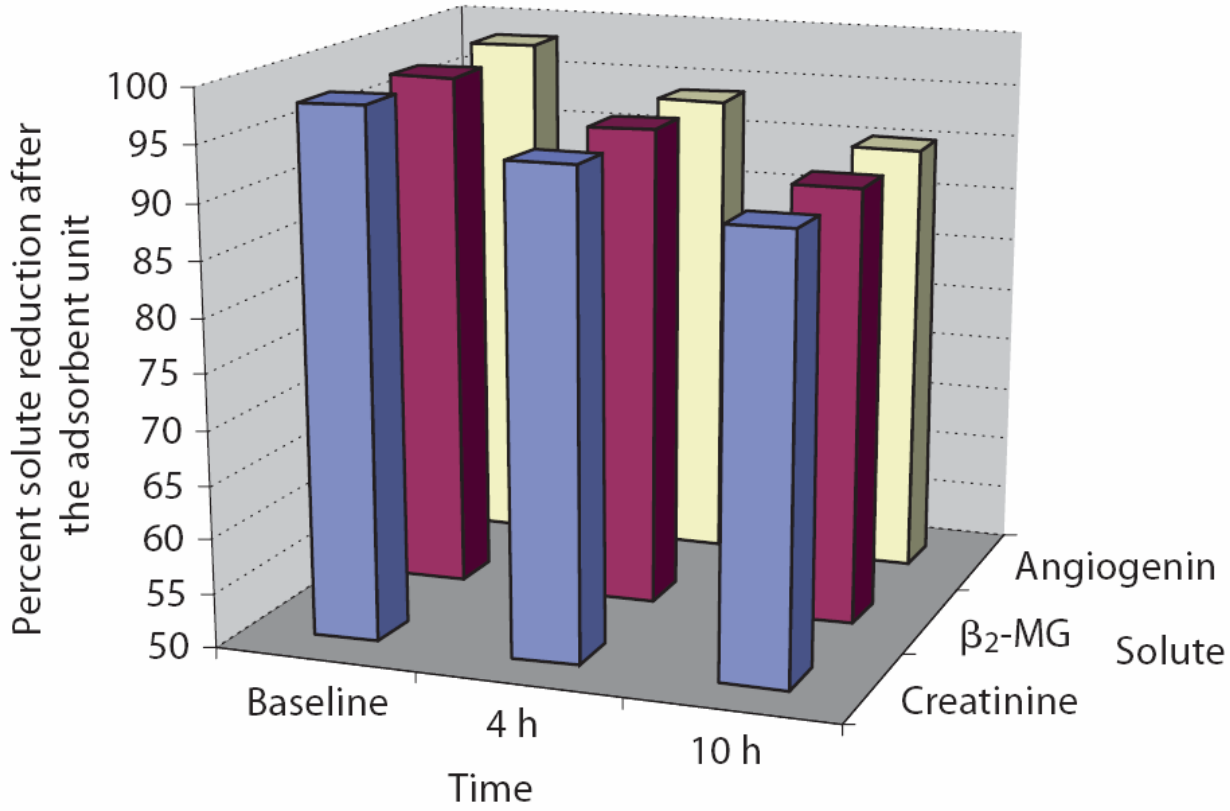
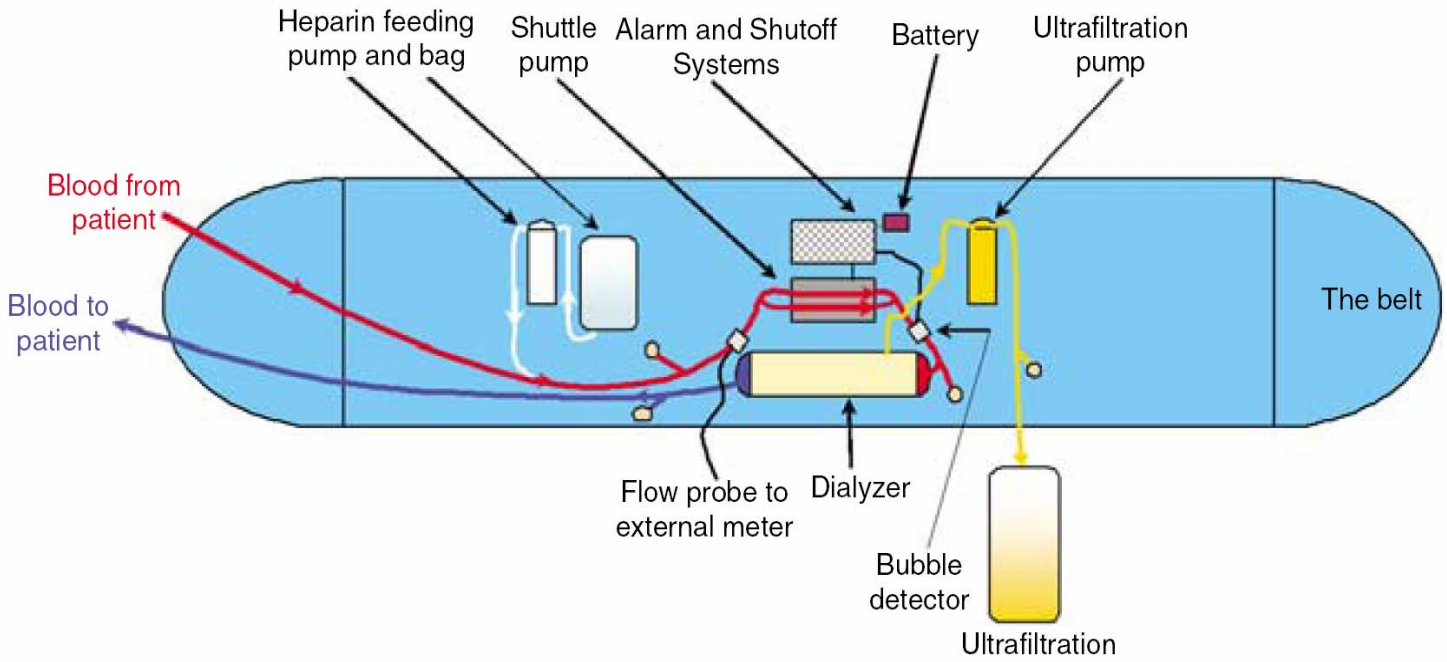


	Baseline	4 h	10 h
Creatinine	98.13 ± 1.21	94.20 ± 3.13	90.10 ± 2.59
β_2-MG	97.88 ± 1.11	99.00 ± 2.88	92.00 ± 2.59
Angiogenin	98.31 ± 1.00	93.88 ± 2.76	90.35 ± 2.20

Blood Purif 2007;25:383–388

Schematics of wearable hemofilter device



Kidney International (2008) **73**, 497–502

Kidney International (2008) **73**, 497–502

Table 2 | Treatment characteristics of the wearable hemofiltration device

Patient no.	Qb (ml min^{-1})	Q_{UF} (ml h^{-1})	Heparin (IU h^{-1})	Rx time (h)	Final aPTT (s)	SC urea	SC creatinine
1	134.2	120	758.3	6	107	1.00	0.97
2	118.9	288	300	4	49	0.96	0.98
3	121.9	120	1000	6	150	0.93	0.96
4	106.1	250	500	6	60	0.88	0.96
5	106.8	175	533.3	6	72	1.00	1.01
6	108.6	200	1000	6	137	1.00	1.01
Mean	116.1	192.1	681.9	5.7	95.8	0.96	0.98
s.d.	11.1	68.3	286.1	0.8	41.9	0.05	0.02

Shows blood flow (Qb), ultrafiltration rate (Q_{UF}), duration of treatment (Rx time), activated partial thromboplastin time (aPTT), and sieving coefficients (SCs) for urea and creatinine.

Table 3 | Patient parameters during treatment with the wearable hemofiltration device

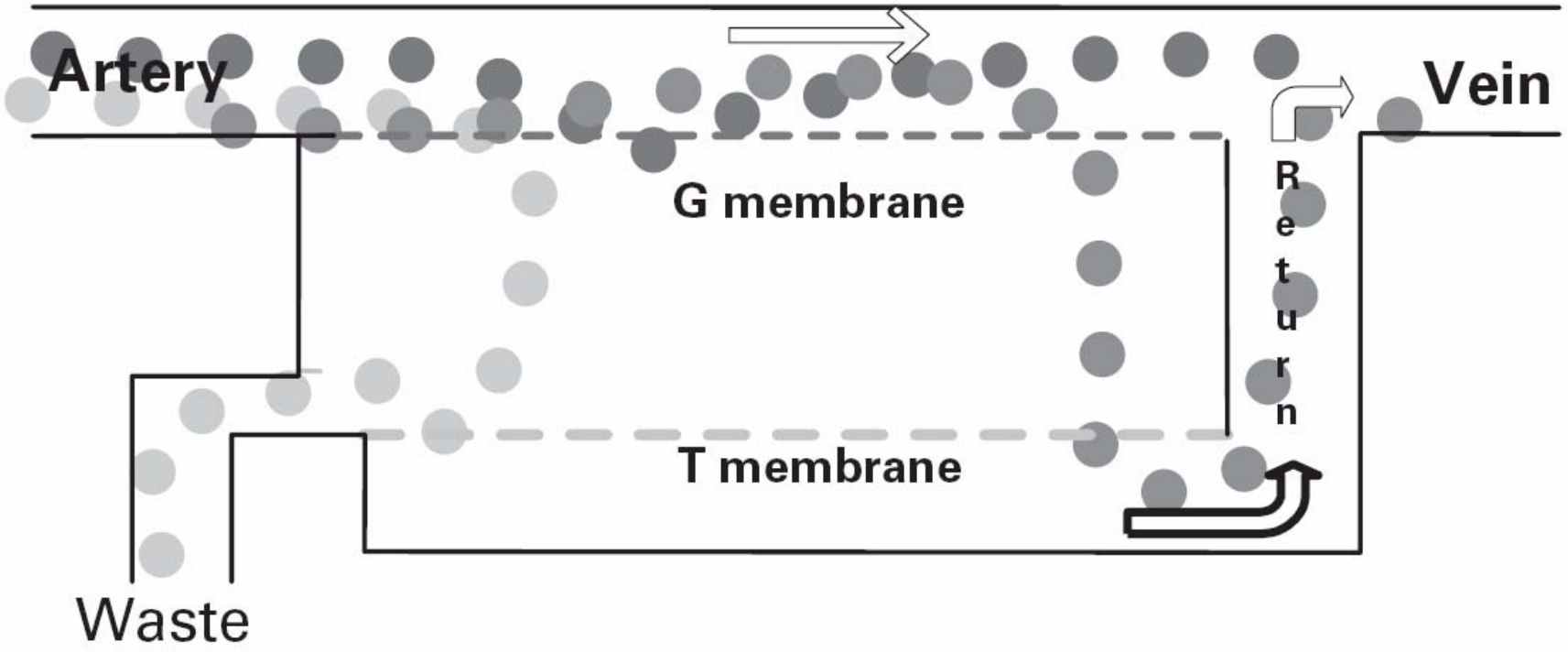
Patient no.	1	2	3	4	5	6	Mean ± s.d.	*P*-value
MAP mm Hg pre-UF	119.0	111.0	90.3	88.3	138.0	109.7	109.4 ± 18.5	
MAP mm Hg post-UF	87.3	111.0	98.7	76.7	120.0	117.0	101.8 ± 17.3	0.03
Total UF (ml)	770	984	708	1610	1233	1201	1084.3 ± 335.4	
Na_{UF} (mmol)	107.8	132.8	97.0	223.8	172.6	171.7	150.0 ± 47.6	

Shows mean arterial pressure (MAP), volume ultrafiltered (UF), and sodium removed in ultrafiltrate (Na_{UF}). Data expressed as mean ± s.d.

MEMBRANLARDAKİ GELECEK

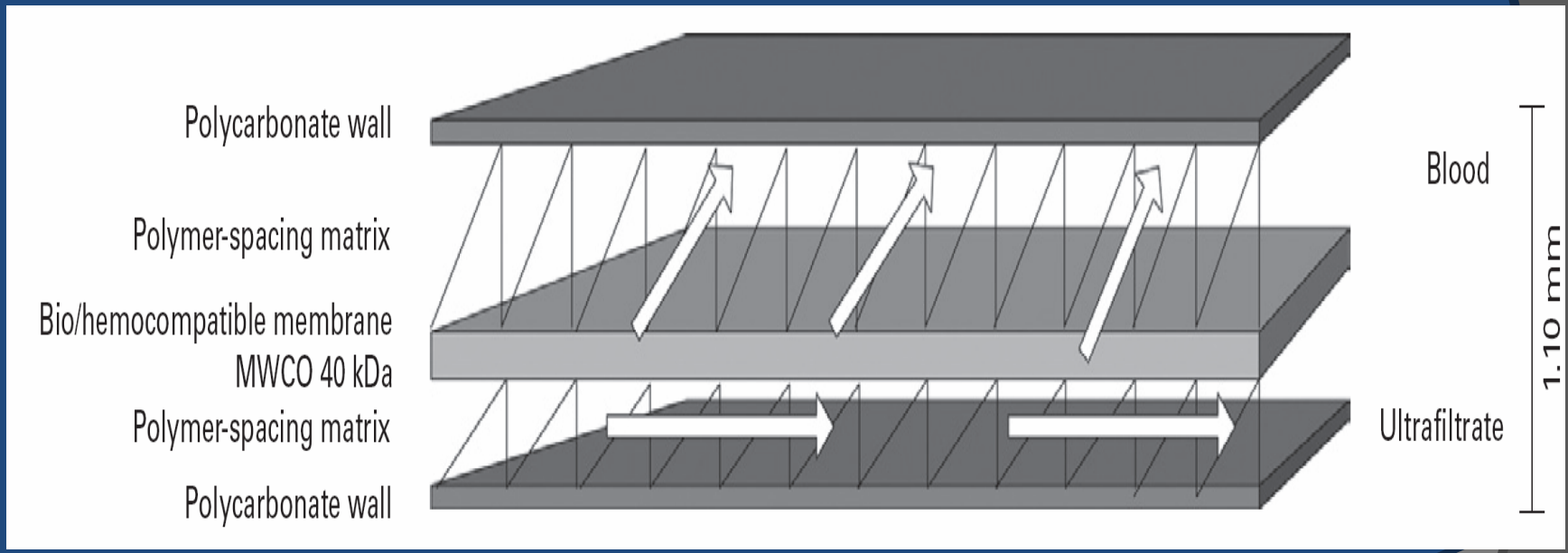
- Microfludics (membransız sistem)
- Nanofabrikasyon
  - Slikon membran
  - Su kanalları
- Yaşayan membranlar

HUMAN NEPHRON FILTER



Blood Purif 2005;23:269–274

G MEMBRAN



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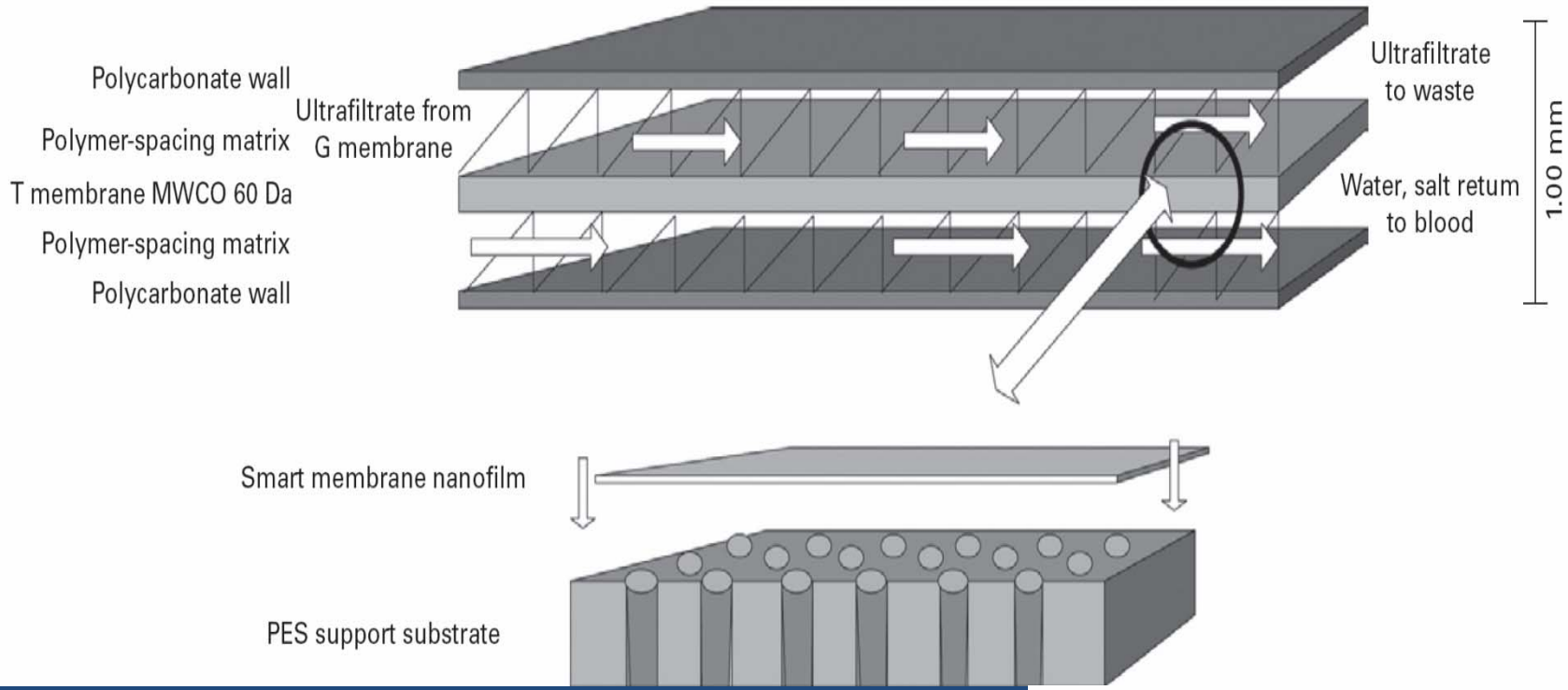
T MEMBRAN



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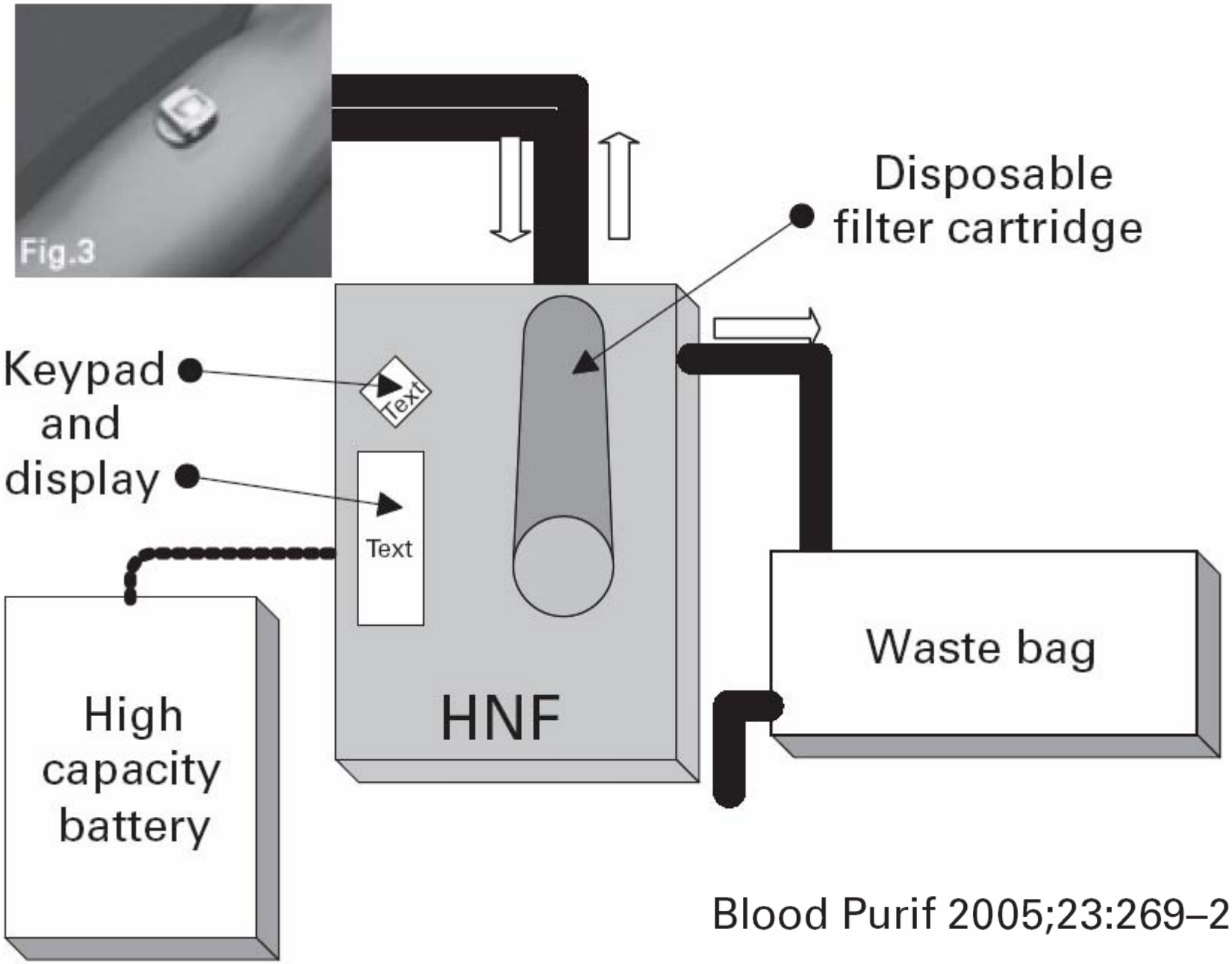

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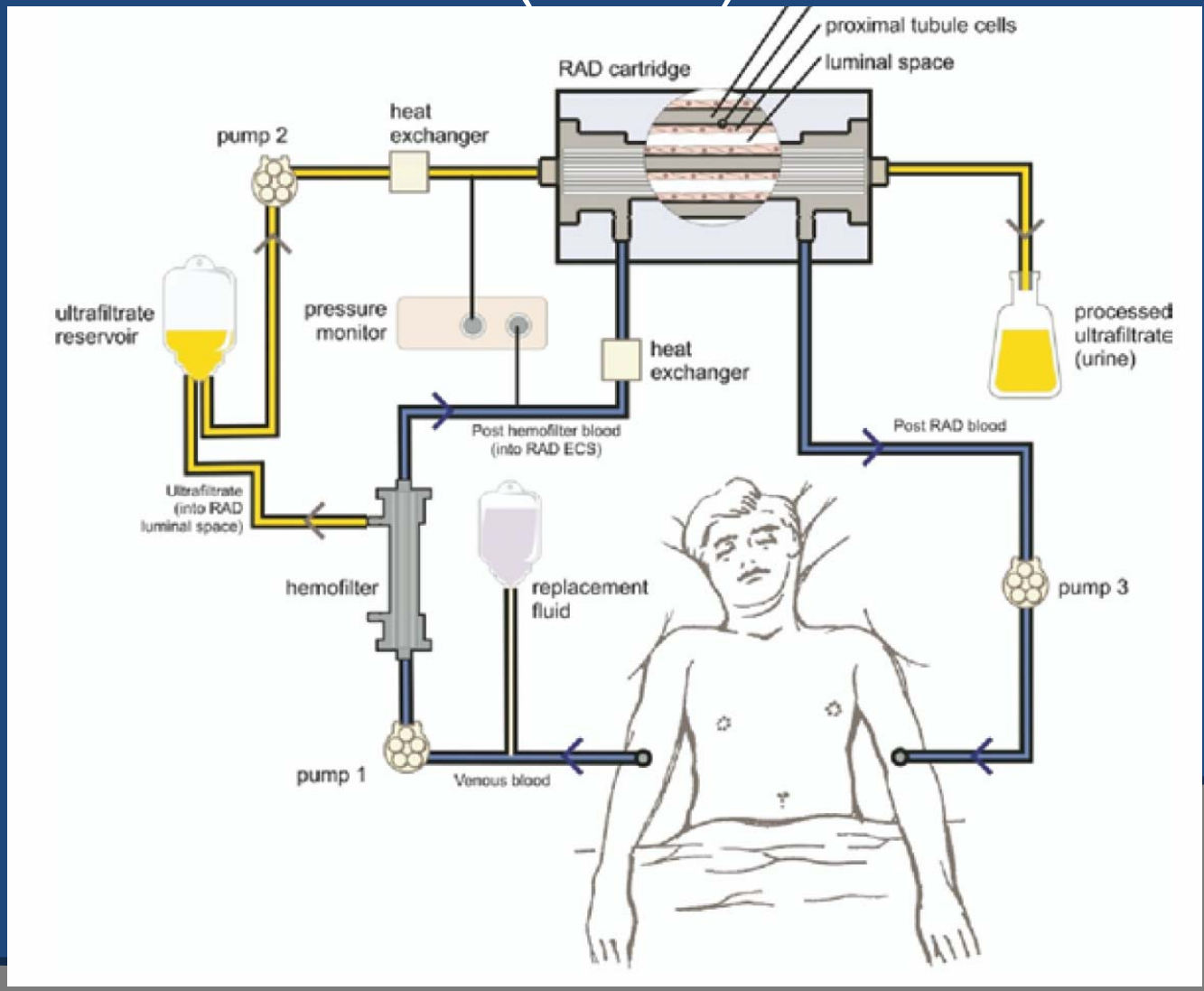
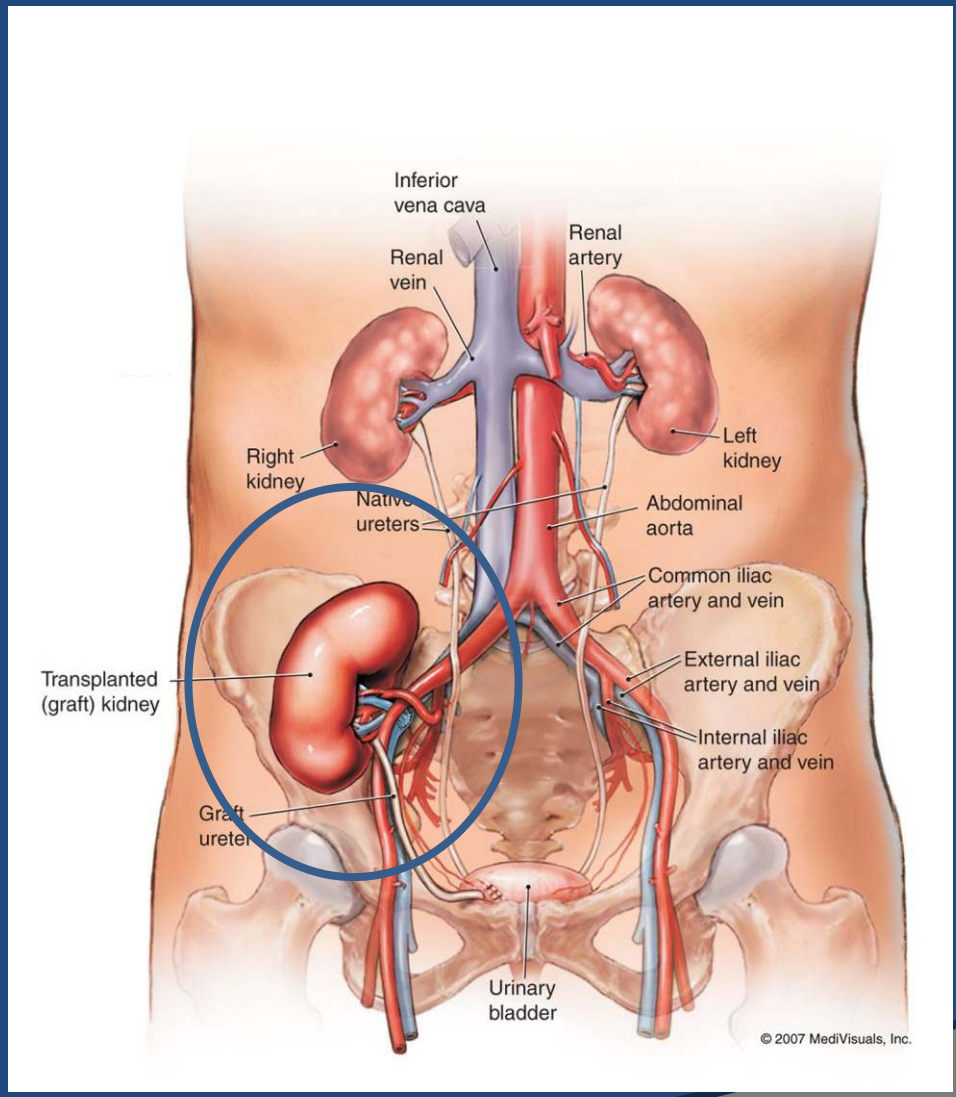
RENAL TUBULE ASSİST DEVİCE (RAD)



*Am J Kidney Dis:*2002; 39:1078–1087

UYUMLU DİYALİZ
DİYALİZ HASTAYA UYAR

ALTERNATİF DİYALİZ


Inferior vena cava
Renal vein
Renal artery
Right kidney
Left kidney
Native ureters
Abdominal aorta
Common iliac artery and vein
Transplanted (graft) kidney
External iliac artery and vein
Internal iliac artery and vein
Graft ureter
Urinary bladder
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