

From a “Portable Kidney” to an Artificial Organ

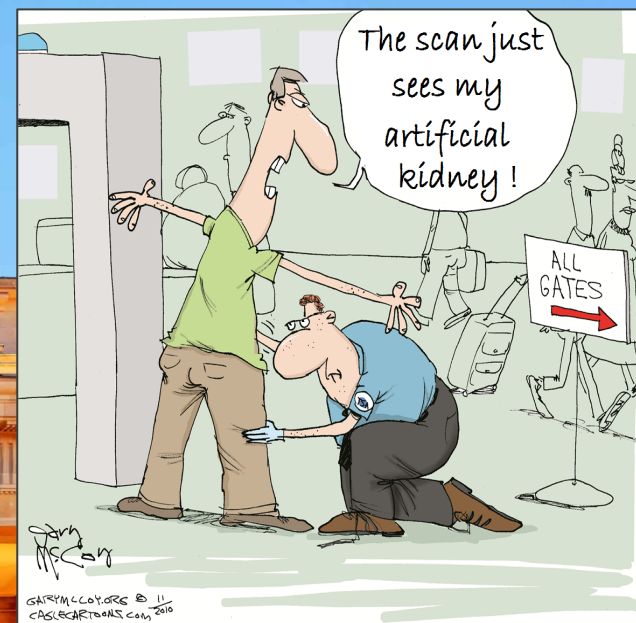
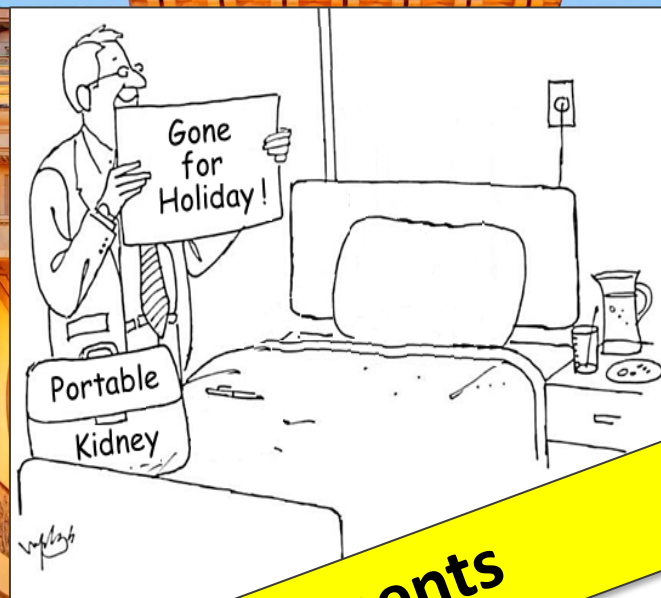
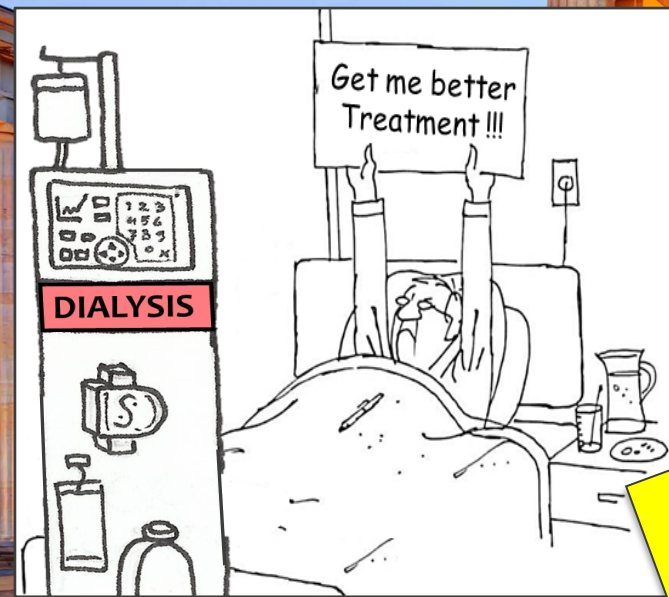
Berliner DialyseSeminar
6-7 Dec 2024

F.P. Wieringa, PhD
Fokko.Wieringa@imec.nl



From a “Portable Kidney” to an Artificial Organ

Berliner DialyseSeminar
6-7 Dec 2024



improvements



Potential conflicts of interest declaration

The content of the following speech is the result of efforts to achieve the maximum degree of impartiality and independence.

As a speaker, I wish to point out that there are **personal connections** to companies whose products are of interest within the context of the following speech. The companies concerned and connections are listed below:

Companies

Connections

(Fee for activities associated with lecturing and in an advisory capacity expert reports and work as an author; fee for preparing training programmes; reimbursement for travel and accommodation costs; reimbursement of participation fees regarding training courses; patents; money from licences and royalties; fee for undertaking commissioned studies; receipt of research funds, etc.)

NextKidney

Consultancy fee for Technological & Regulatory issues

Bundle the Best Brains to Build Better Treatments



Patients



Doctors & Nurses



Policy makers



Inventors & Investors



Engineers



Entrepreneurs

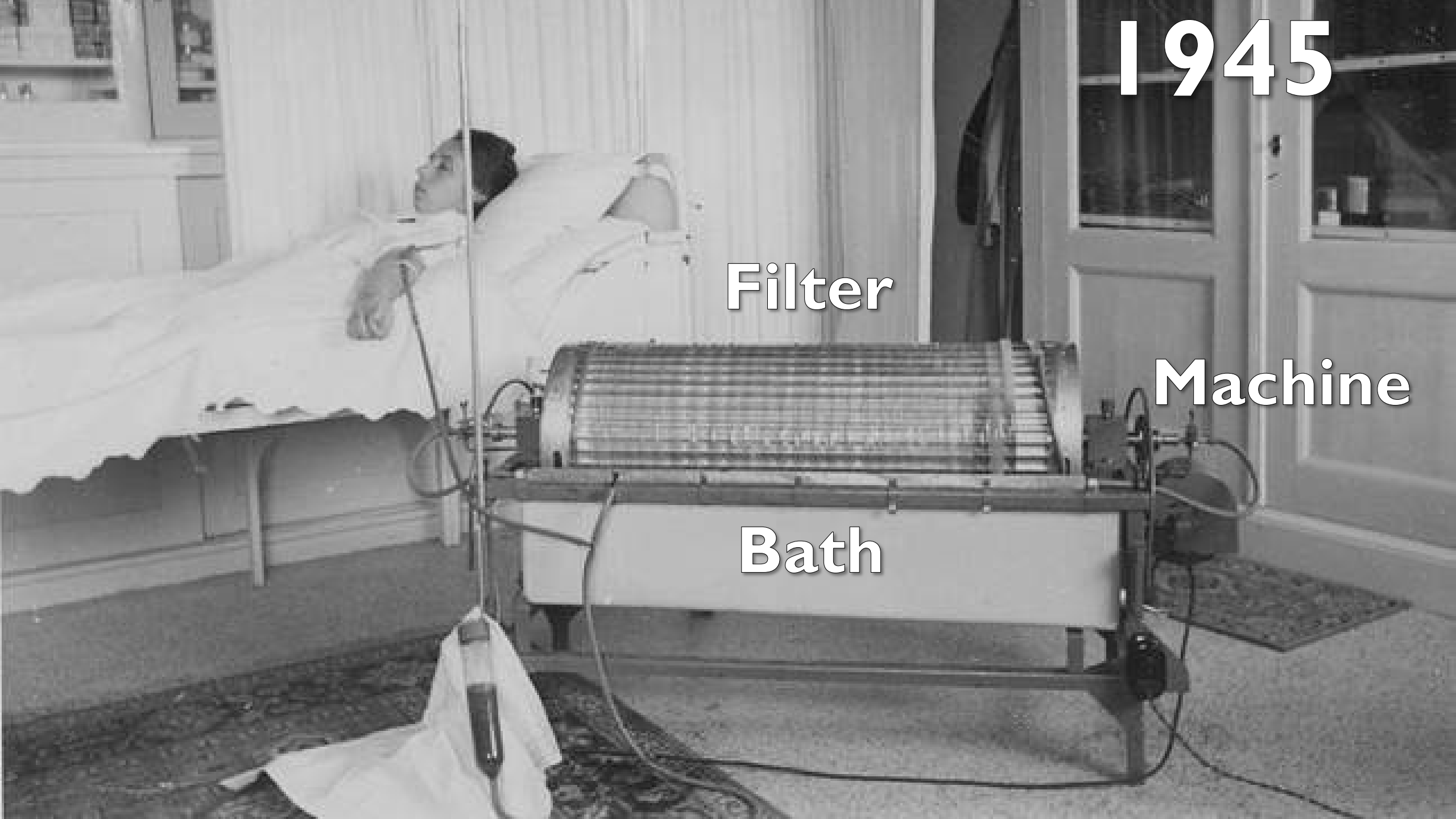


1945

Filter

Machine

Bath

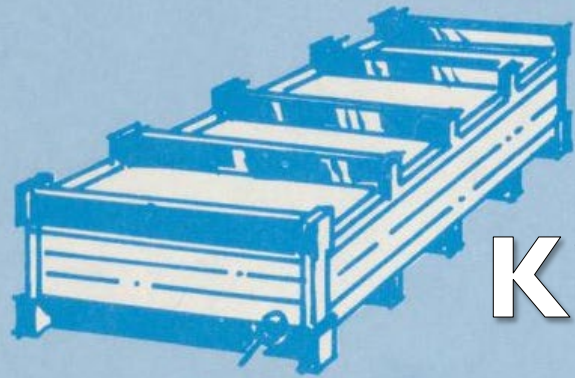


1967: USA Health Education Flyer

Cellophane is the basic part of an amazing device which saves many lives each year . . .

THE ARTIFICIAL KIDNEY!

ARTIFICIAL KIDNEYS LOOK LIKE



Kiil

THIS*



Bath

*the cellophane is inside.

cellophane is inside

Magnified thousands of times,
cellophane sheet looks like this

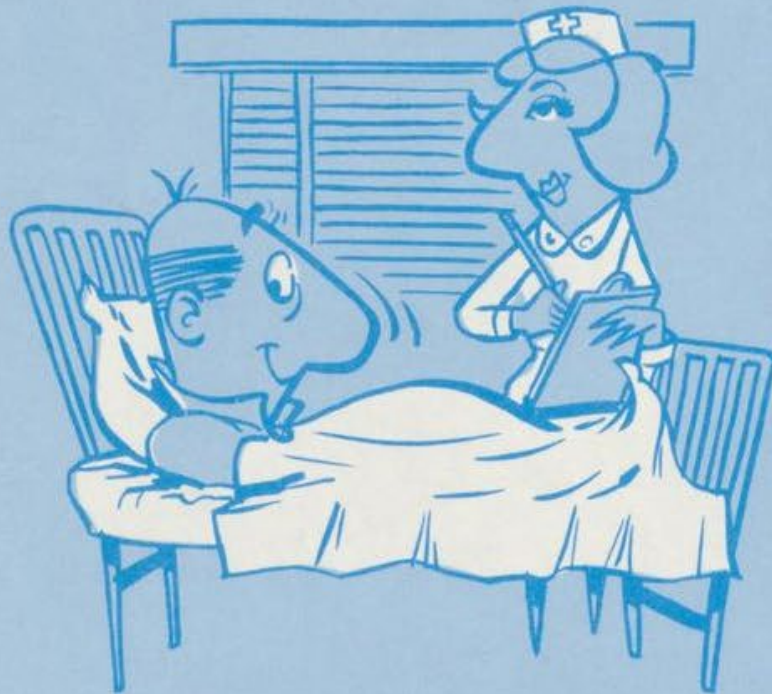


1967: USA Health Education Flyer

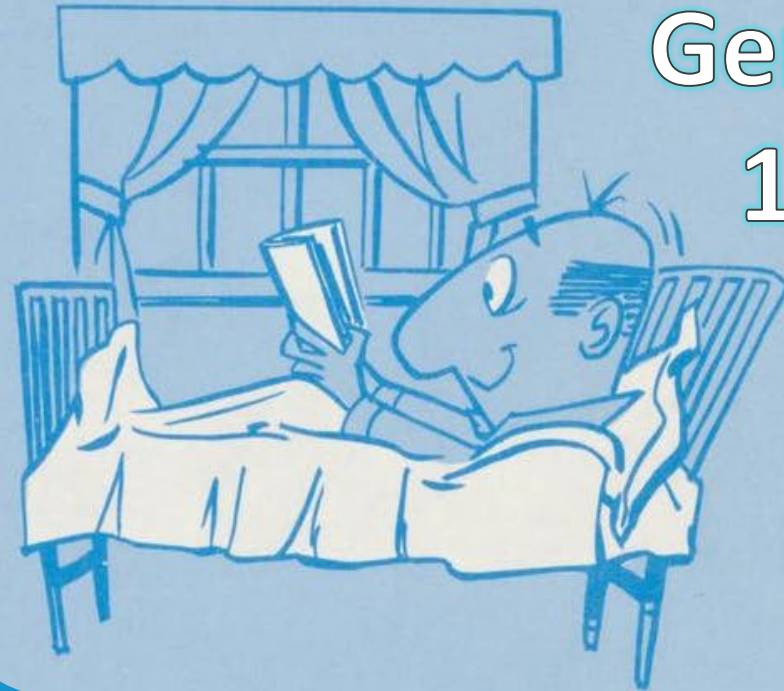
If these measures fail, some patients may be suitable candidates for a CHRONIC DIALYSIS program.

CHRONIC DIALYSIS has been conducted in:

DIALYSIS CENTERS



HOMES



1970:

Germany

100%

Back to the Future:

Time to Return to Home Dialysis!



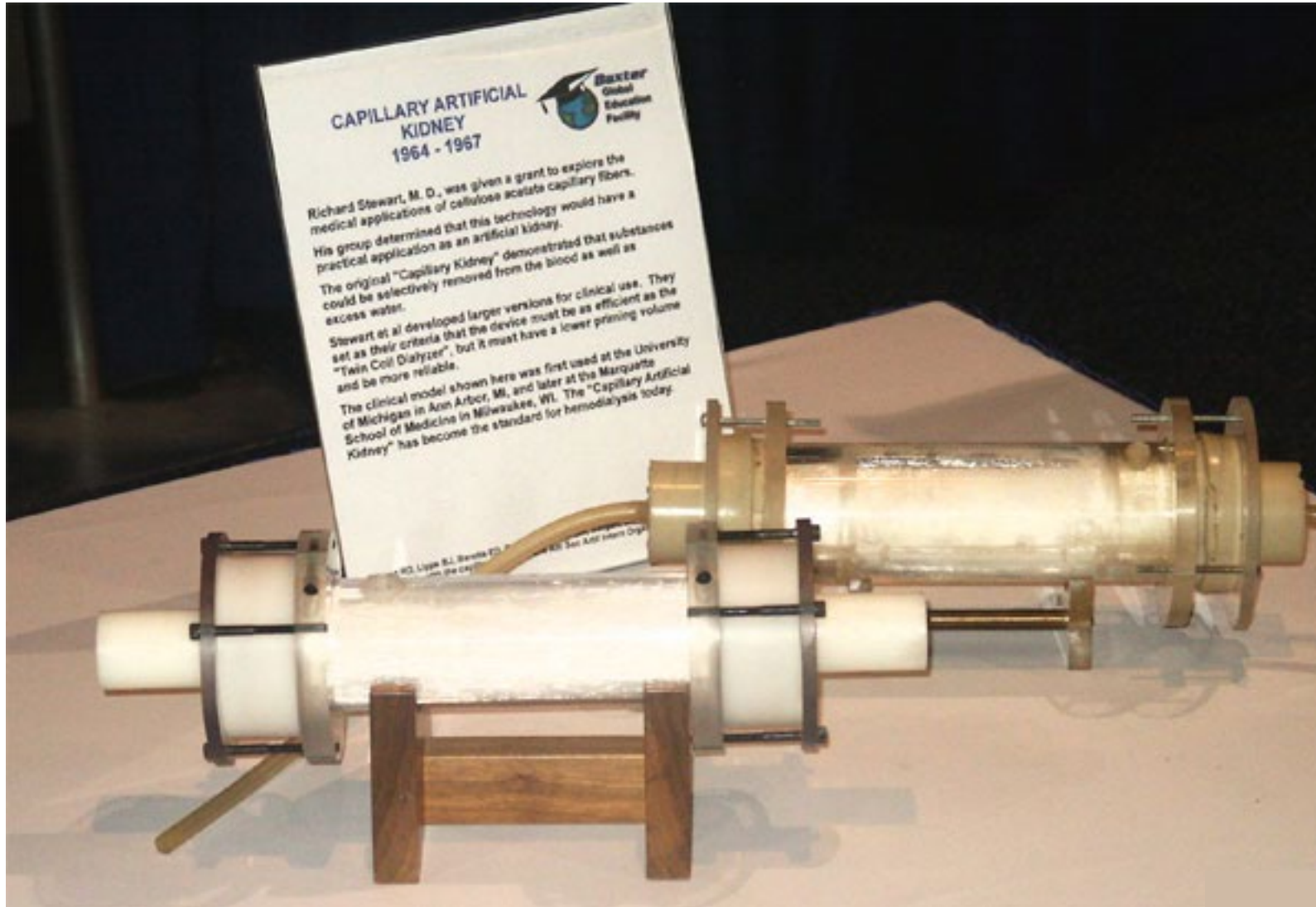
DECADE OF THE KIDNEY™

AAKP

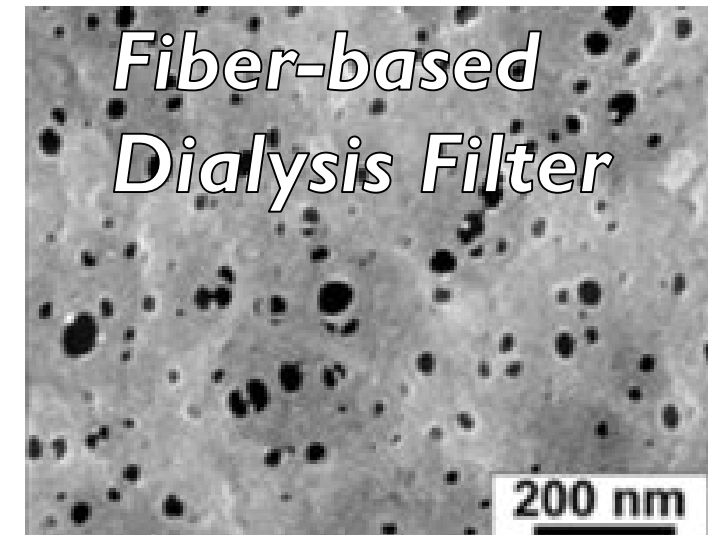
EKHA

2020-2030

1967: Hollow Fiber based Dialyzer on the Market



In 1964, Richard Stewart, MD, showed that hollow cellulose acetate capillary fibers could selectively remove toxins from the blood, as well as excess water. The improved model shown here was first used at the University of Michigan in Ann Arbor, and later at the Marquette School of Medicine in Milwaukee. **Hollow fiber dialyzers still are the standard approach for HD today.**



Single Pass Approach Limits Miniaturization...



Single Pass machines getting Transportable



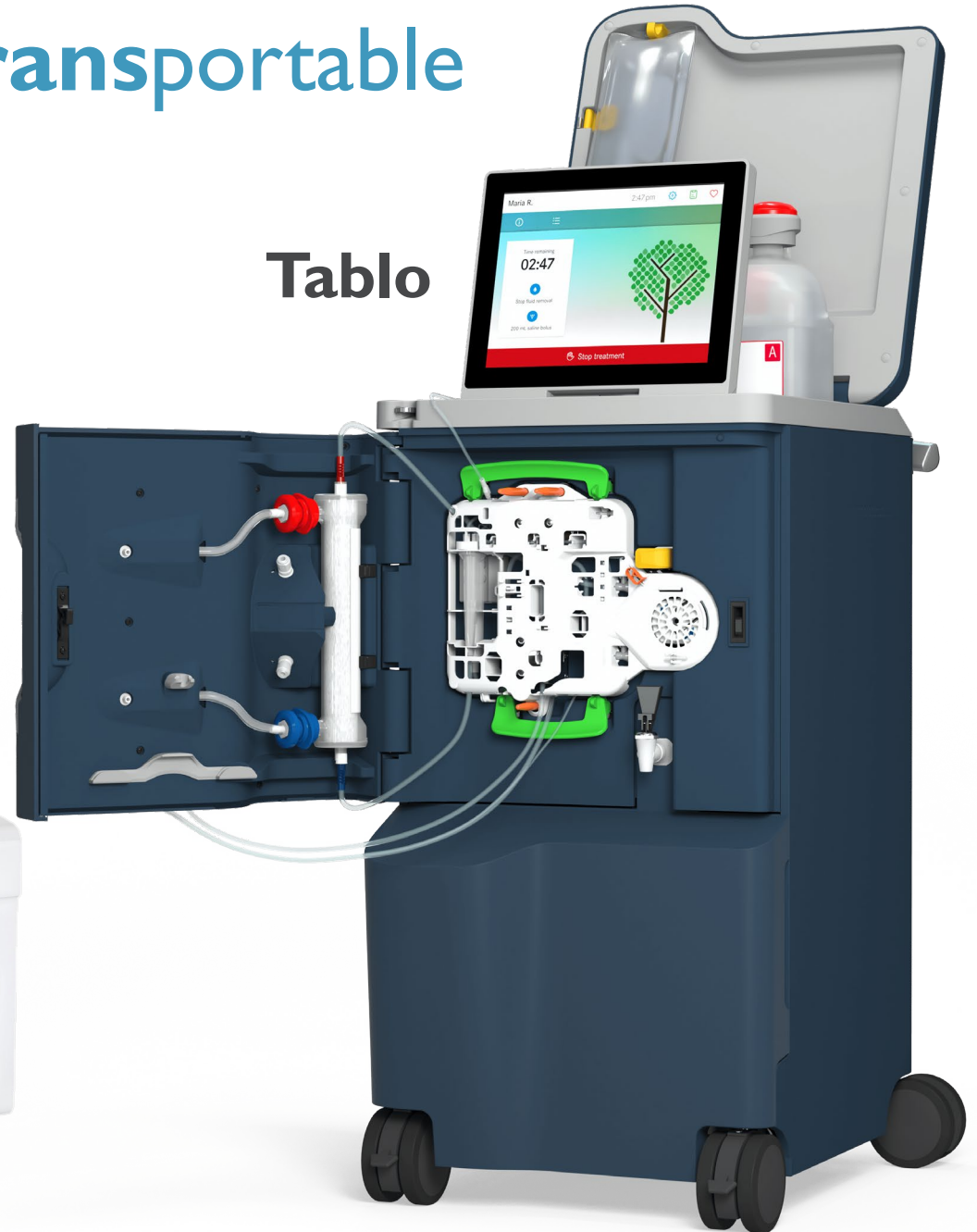
NxStage® VersiHD™



Quanta SC+

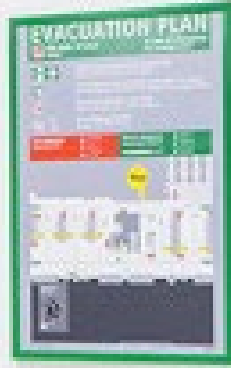


Physidia



Tablo

Distance
Odd-size baggage
Afwijkende bagage



What if **You** are entering **Here**

Your **Machine** *should* enter **Here**


But *ends*
Here...



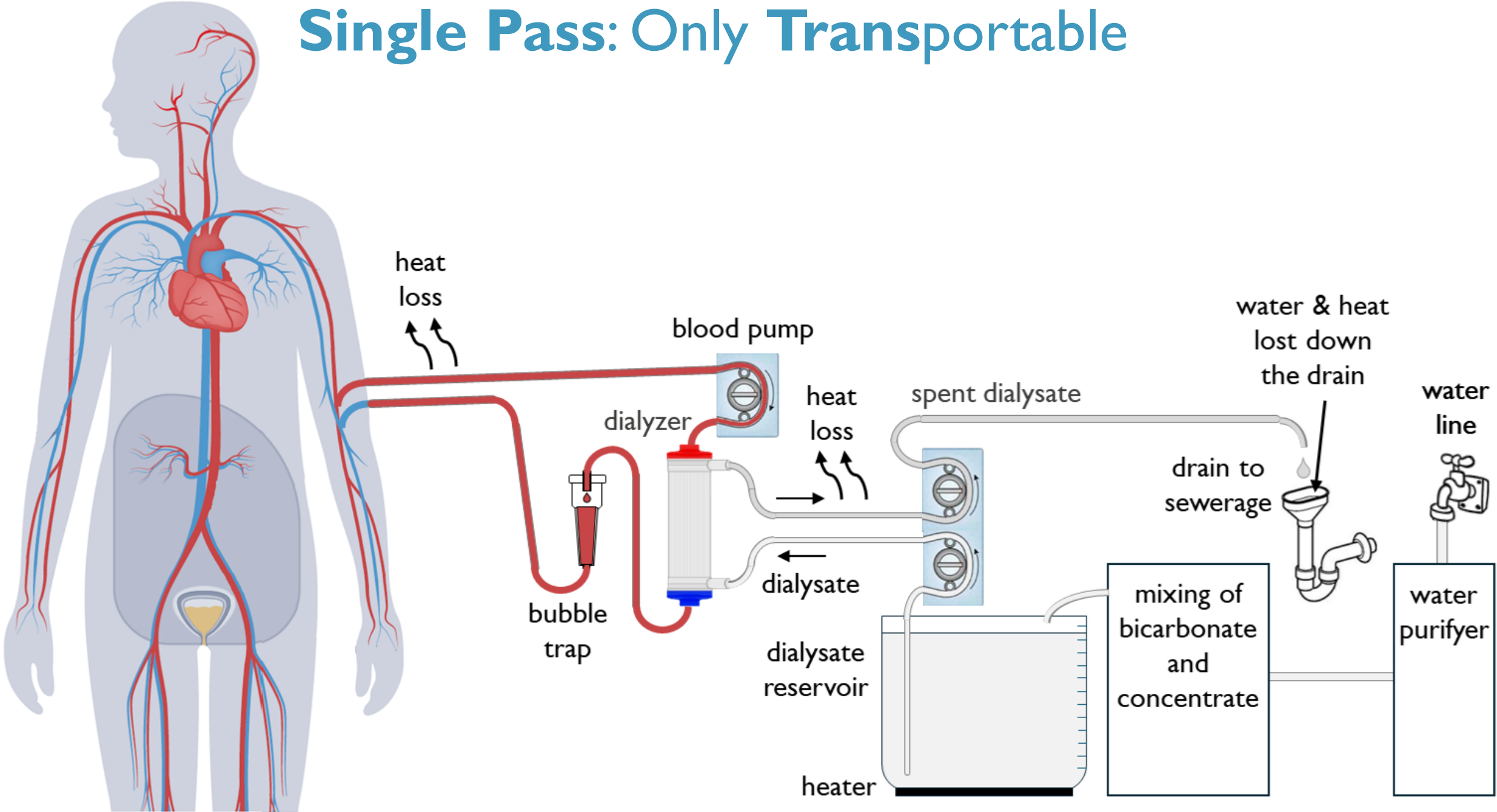
Patients: "Only Hand Luggage is Truly Portable!"

CKJ REVIEW

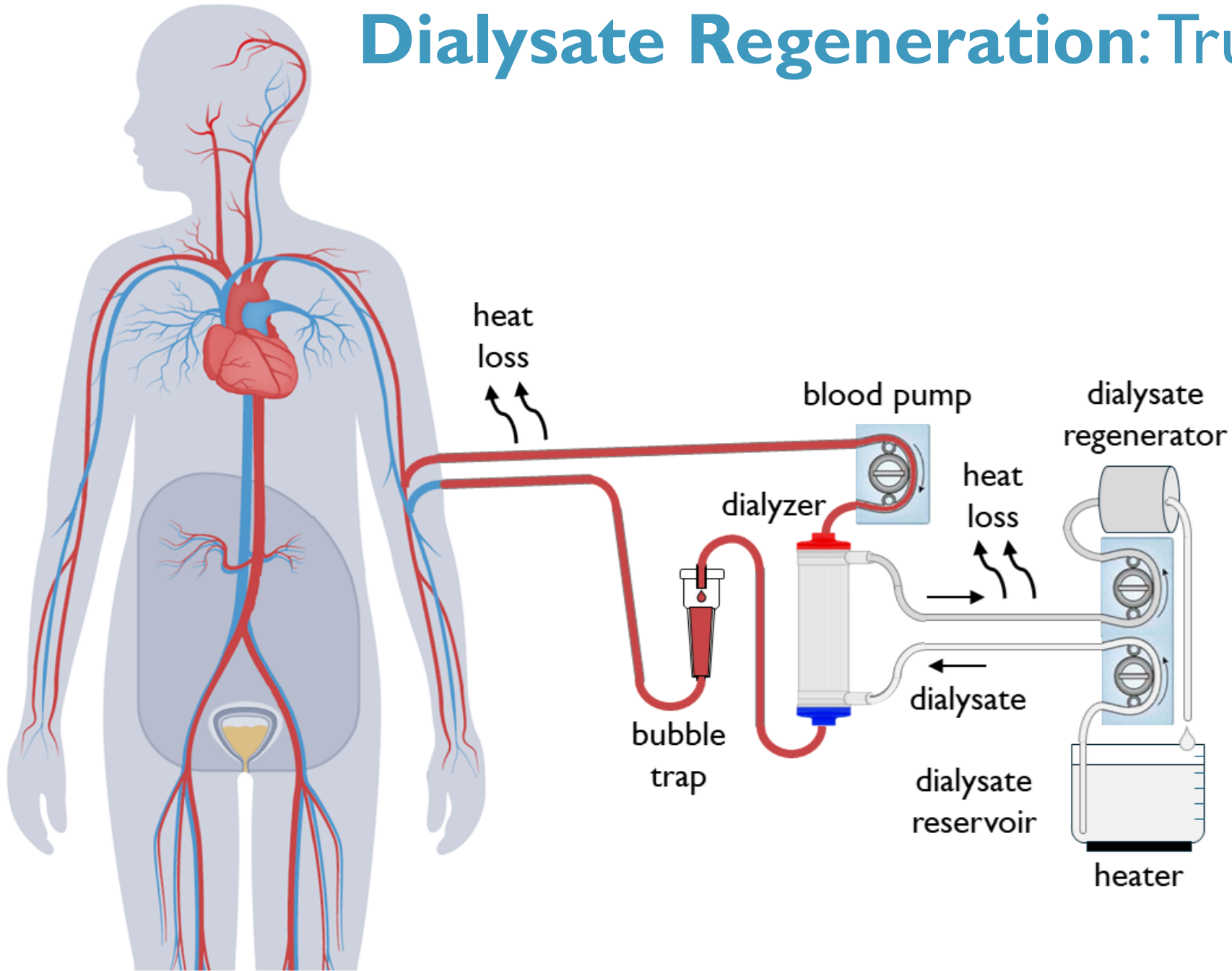
Transportable, portable, wearable and (partially) implantable haemodialysis systems: comparison of technologies and readiness levels

Fokko P. Wieringa ^{1,2,3,4}, Dian Bolhuis², Henning Søndergaard^{3,5}, Stephen R. Ash⁶, Cian Cummins⁷, Karin G.F. Gerritsen^{2,8}, Jeroen Vollenbroek^{1,2,9} and Tugrul Irmak^{2,3}

Single Pass: Only Transportable



Dialysate Regeneration: Truly Portable





**KIDNEY
WEEK**









National University Hospital Singapore

Portable Artificial Kidney Sorbent Cartridge Study

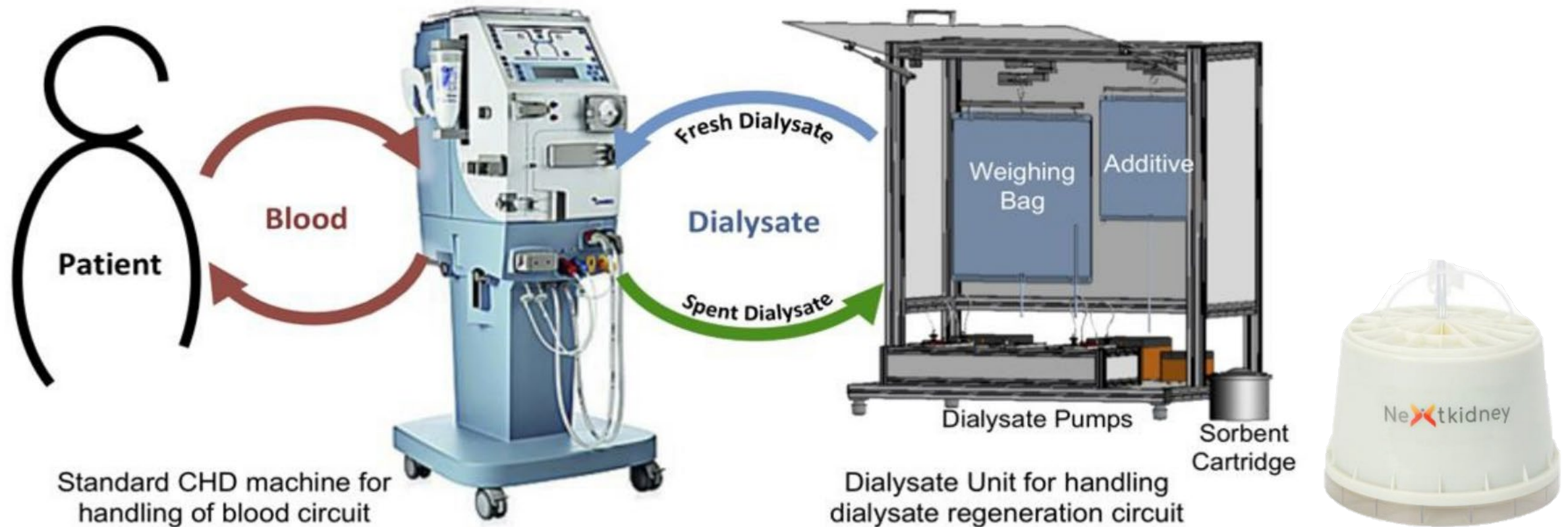
Titus Lau and Sabrina H Wong



National University Hospital Singapore

Portable Artificial Kidney Sorbent Cartridge Study

Titus Lau and Sabrina H Wong



PAK Sorbent Cartridge FIH Trial: setup

- **Dialyzer:** High-Flux 1.8m2
- **Blood flow rate:** 300ml/min
- **Dialysate flow rate:** 300ml/min
- **Intervention:** 1x2h PAK treatment in a clinical setting
- **Completion:** additional 2hr of CHD after PAK treatment
- **Control:** same as above (1x4h CHD)

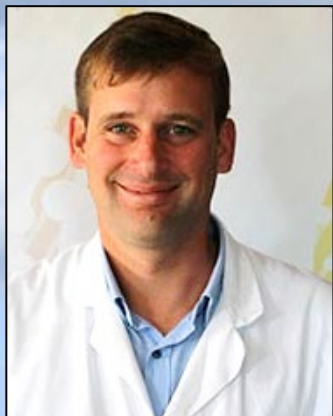


PAK Sorbent Cartridge FIH Trial – Conclusion

- The safety and efficacy of the Neokidney sorbent system were demonstrated in all 3 patients. There were no device related adverse events (AE's) and no device deficiencies (DD's)
- The toxin clearance was equivalent to CHD
- The biochemical parameters were within the required design specifications (Na, HCO₃, Ca, Mg, K)

Phase 3 Sorbent Cartridge is ready for full system trials with the NeoKidney device





University Hospital Caen (France)

← Dr. Maxence Ficheux





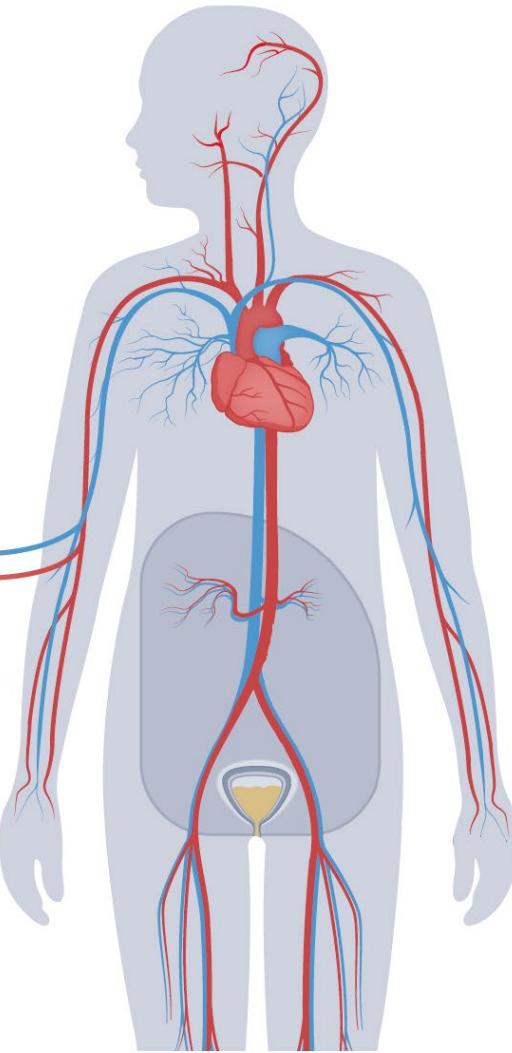
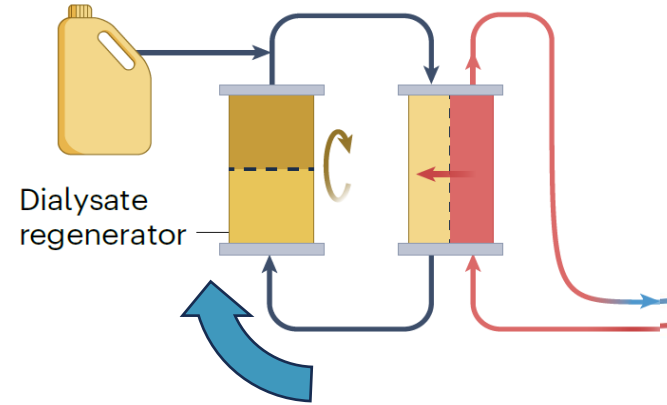
University Medical Centre Utrecht (Netherlands)

← Dr. Karin Gerritsen



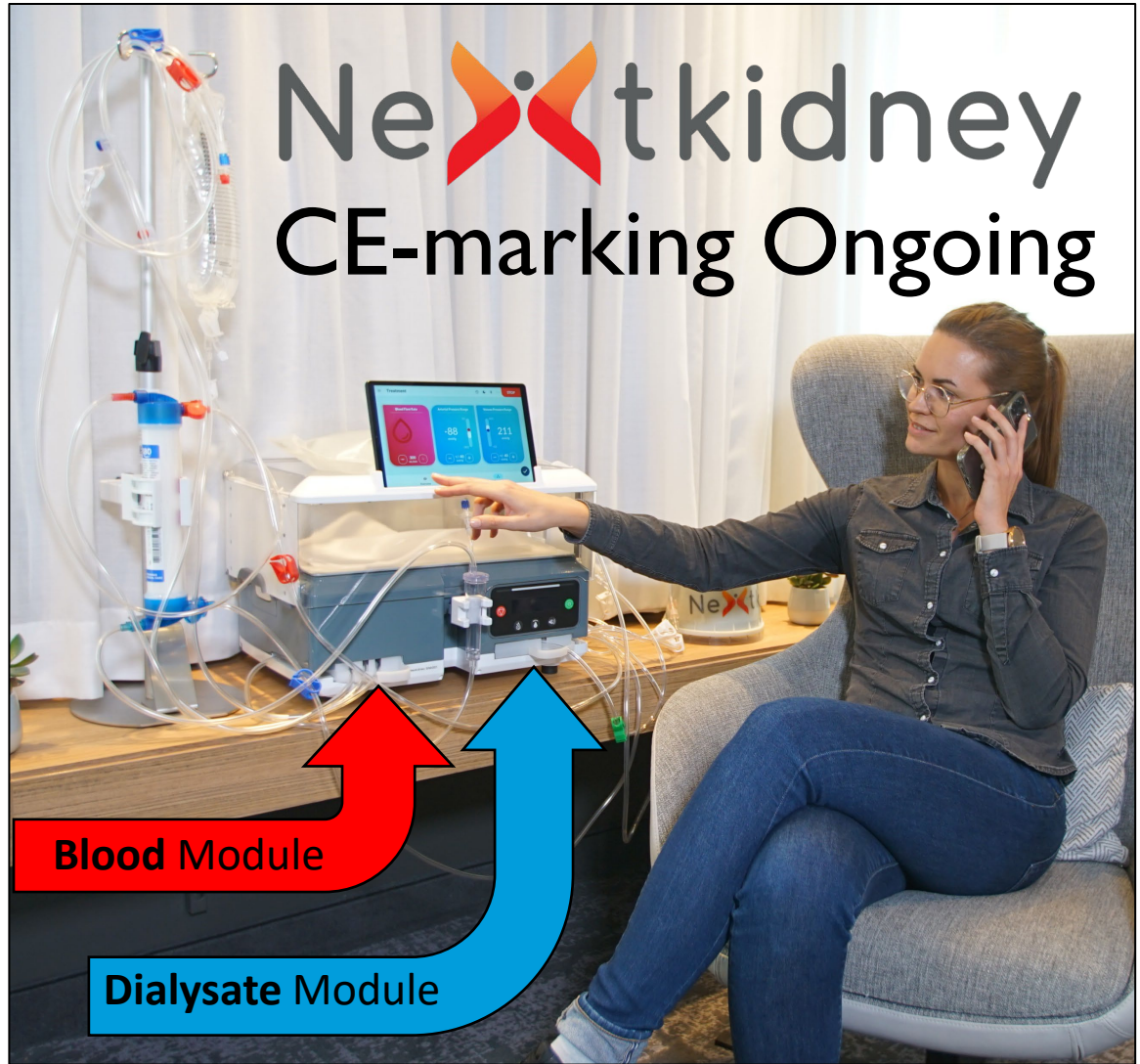
Sorbent System

Portable and/or wearable haemodialysis



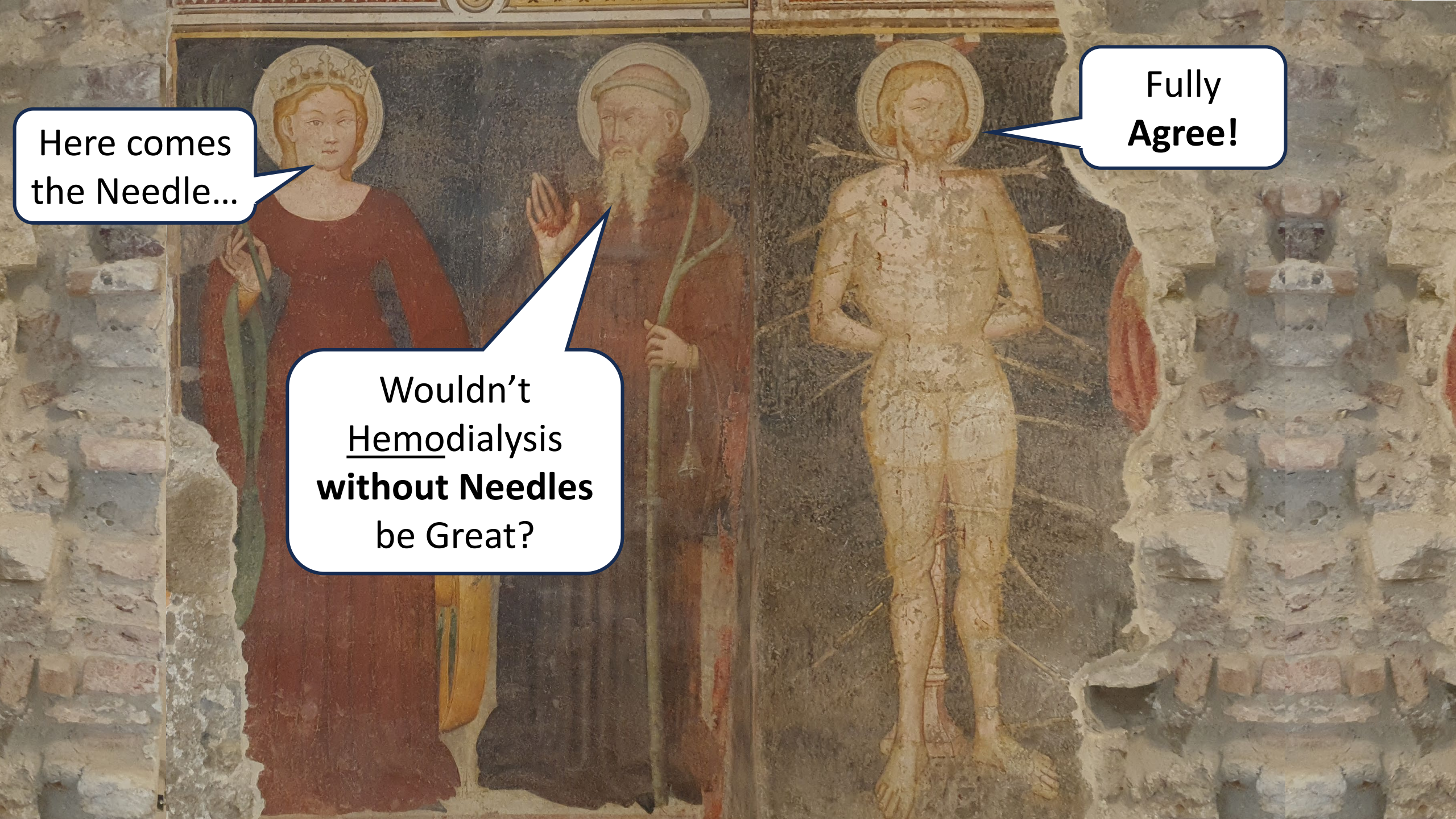
Closed Circuit:

- Saves Water
- Saves Energy
- More Portable



NeXtkidney
CE-marking Ongoing

Die Zukunft der Nierenersatztherapie.
F. Wieringa. Nephrologie aktuell 2023; 27: 26–30



Here comes
the Needle...

Wouldn't
Hemodialysis
without Needles
be Great?

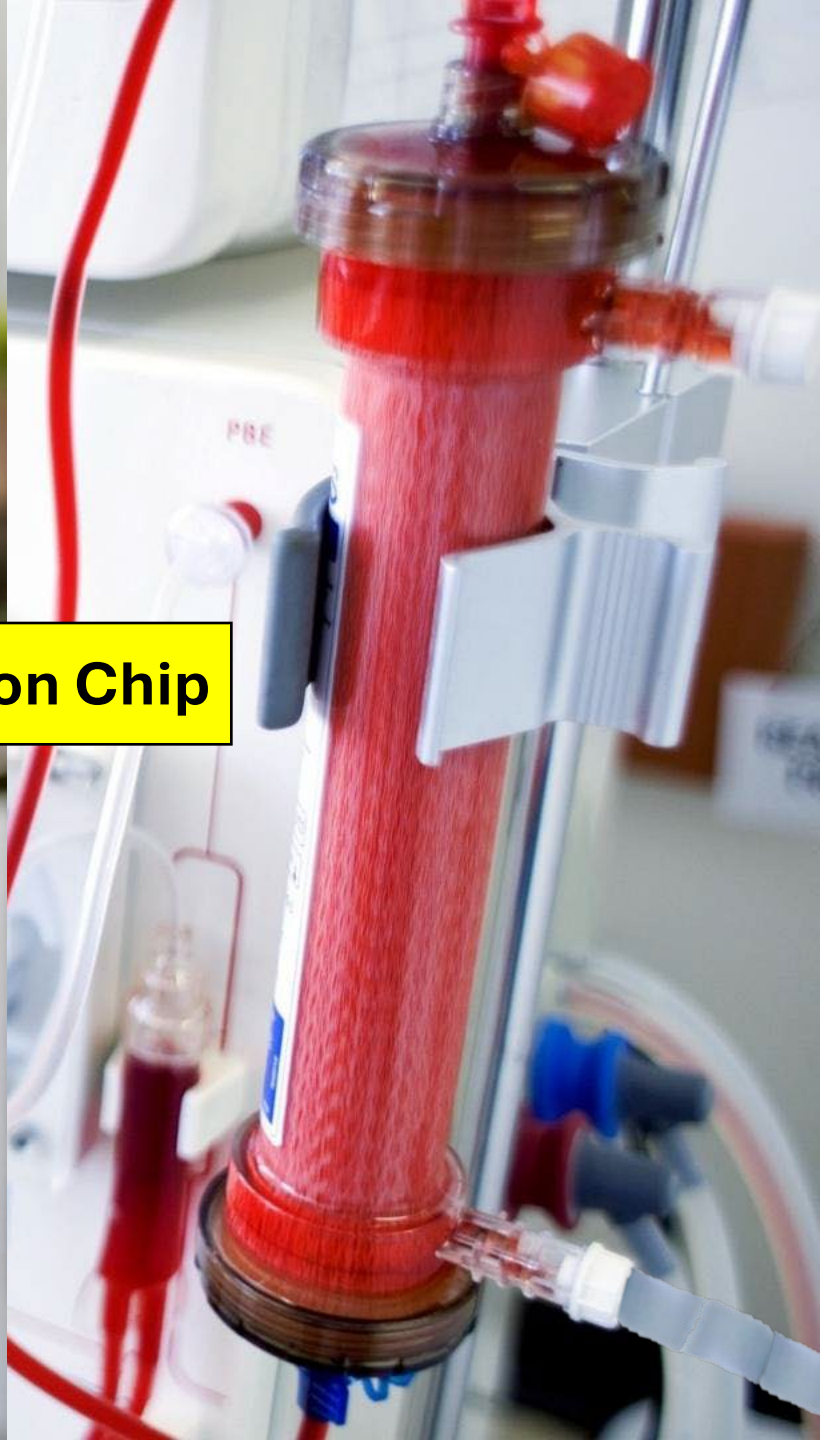
Fully
Agree!

**A Concrete Example to
Increase Health, while
Saving Money & our Planet**





← **Miniaturize on Chip**



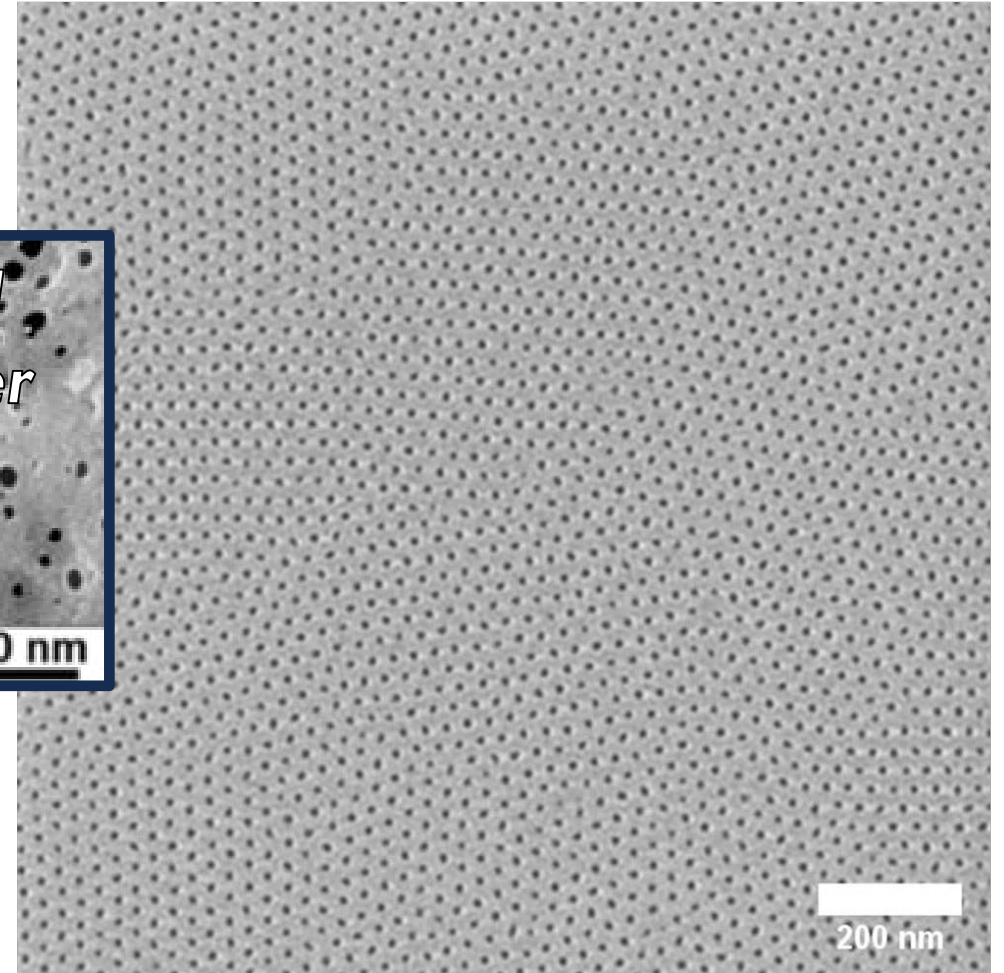
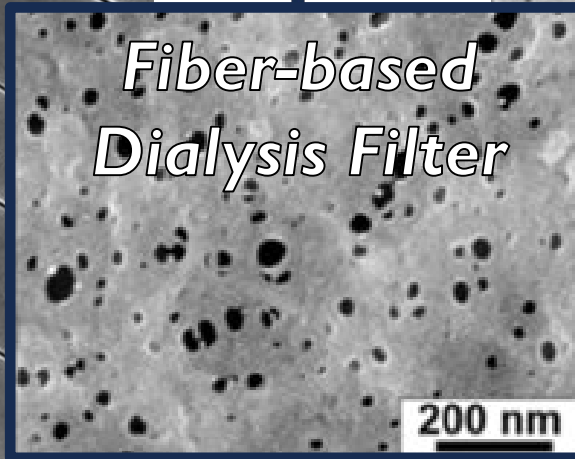
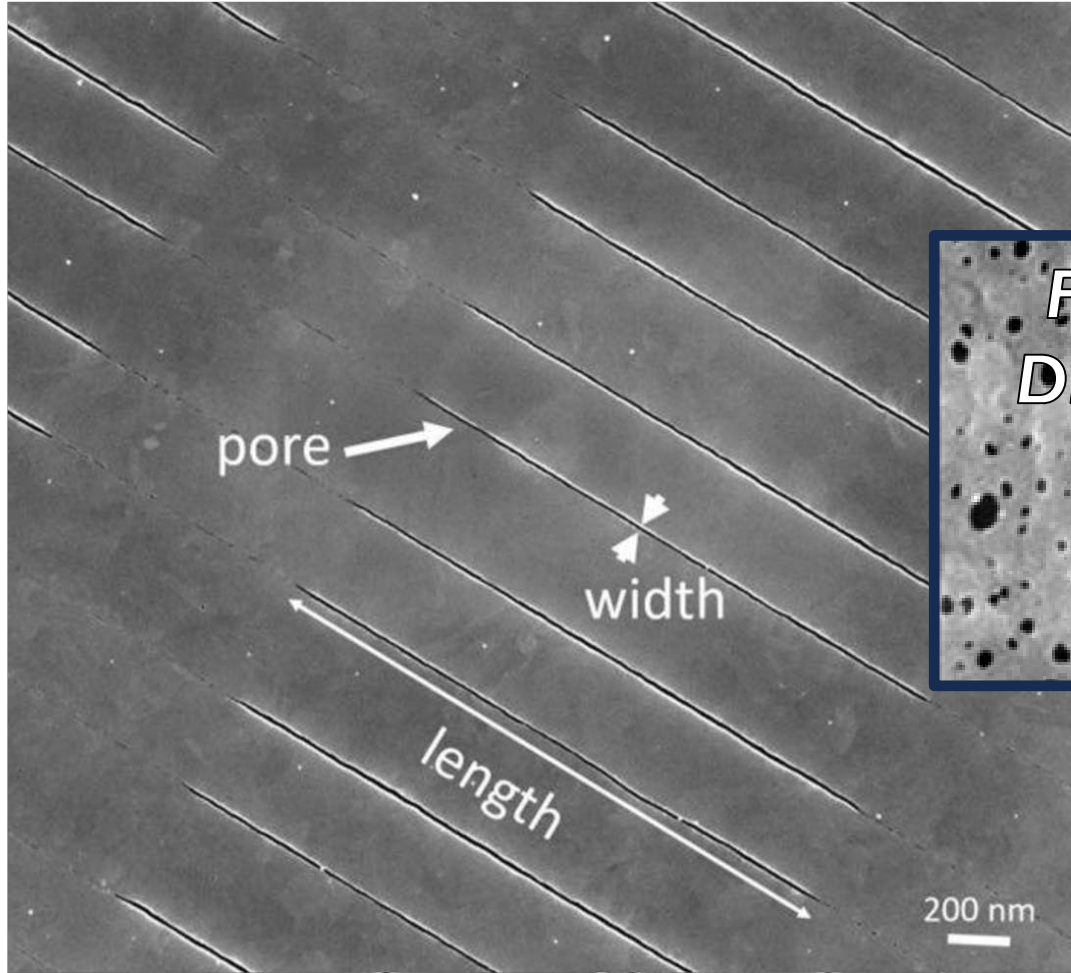


THE
KIDNEY
PROJECT

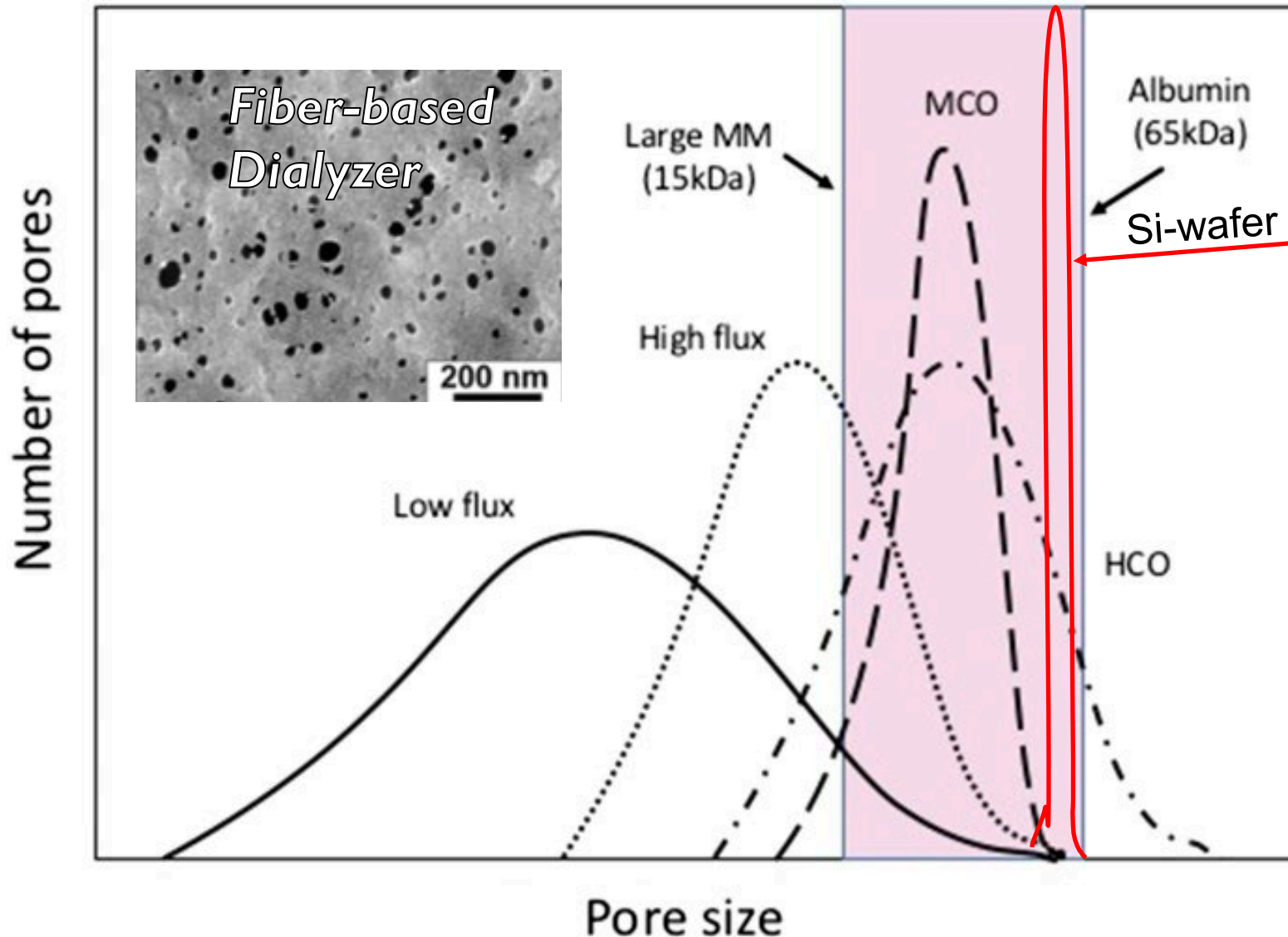


KIDNEW

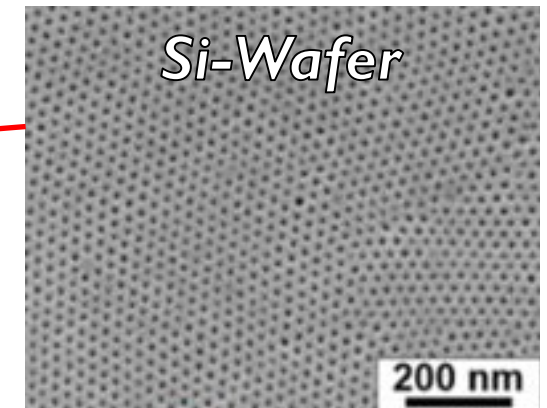
NXT
GEN
HIGHTECH



Si-wafer based filters: Steep Cutoff & Super Porous



Average human hair diameter is 250x the size of the 200nm scale bar

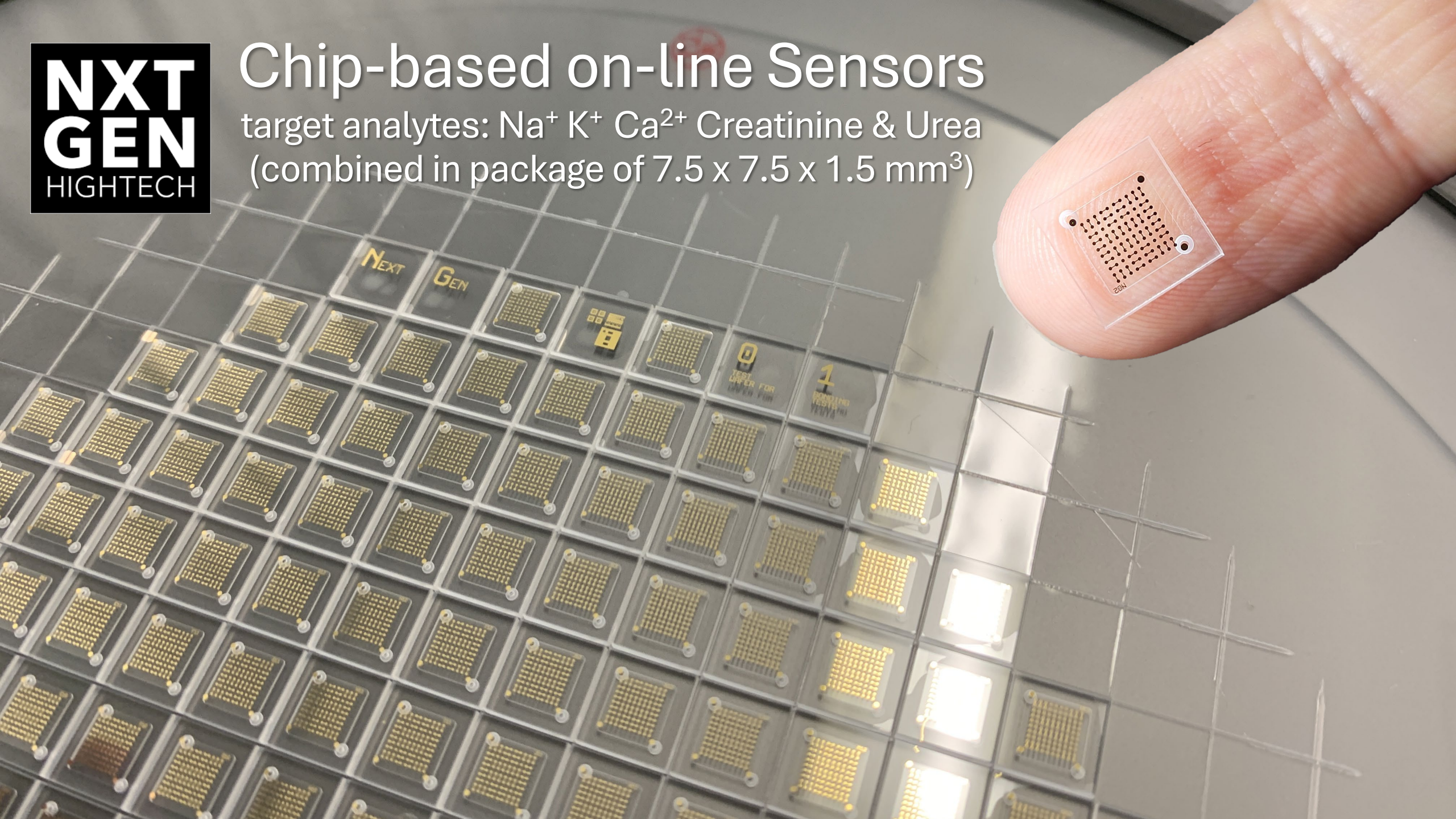


Engineering Ultrathin Si Membranes with sub-20 nm Pores at Wafer Scale.
Cummins C *et al.*
Paper presented at 49th International conference on Micro & Nano Engineering, MNE 49, Berlin, Germany 2023.




Chip-based on-line Sensors


target analytes: Na^+ K^+ Ca^{2+} Creatinine & Urea
(combined in package of $7.5 \times 7.5 \times 1.5 \text{ mm}^3$)



**NXT
GEN**
HIGHTECH



KIDNEW



UMC Utrecht





Dialysis Anywhere

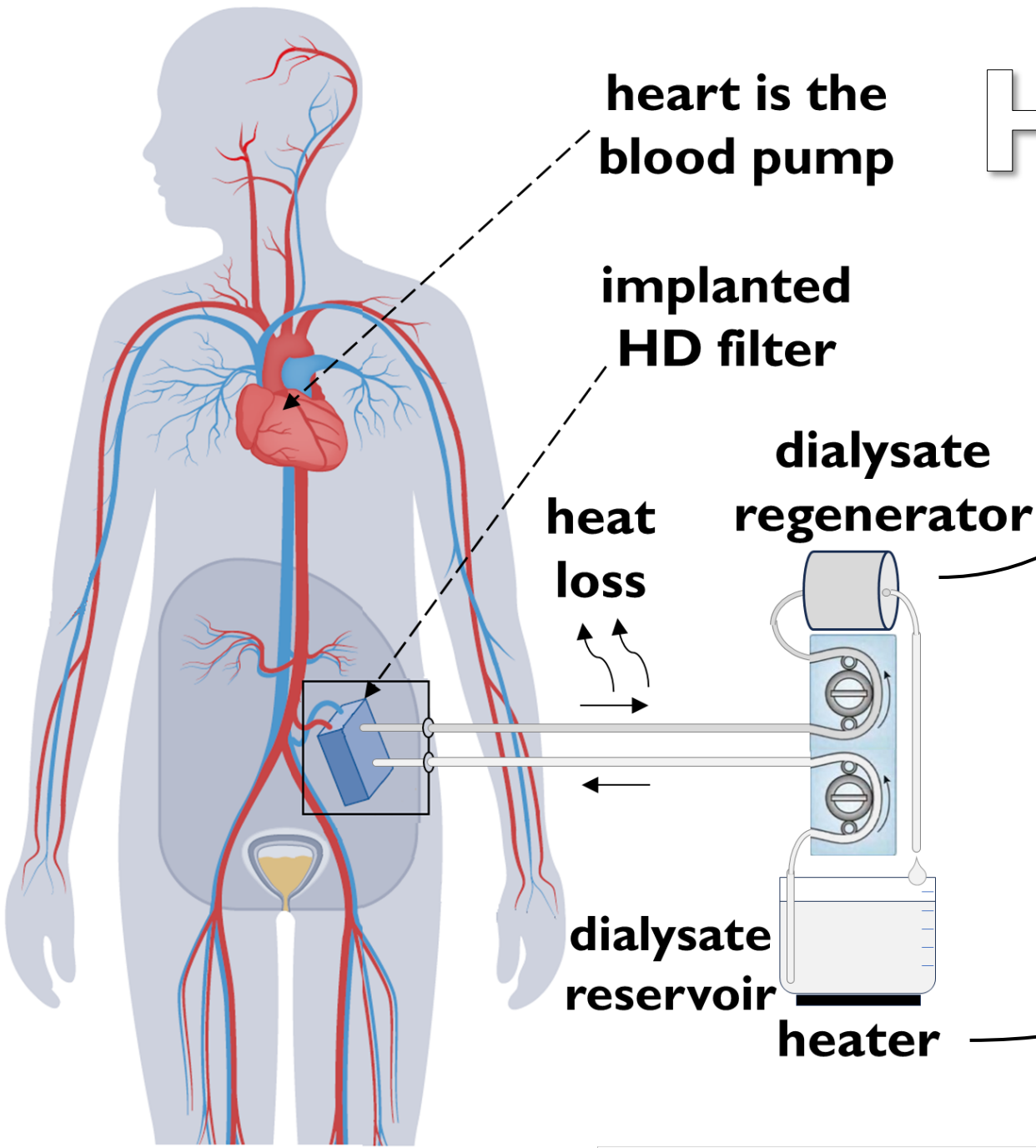
Nextkidney

1:00
92.2%

SHOW D BUDDY
Nextkidney

KIDNEY
FOLKLO WIERING
NON-MEMBER

KIDNEY
BUDDY
NON-MEMBER

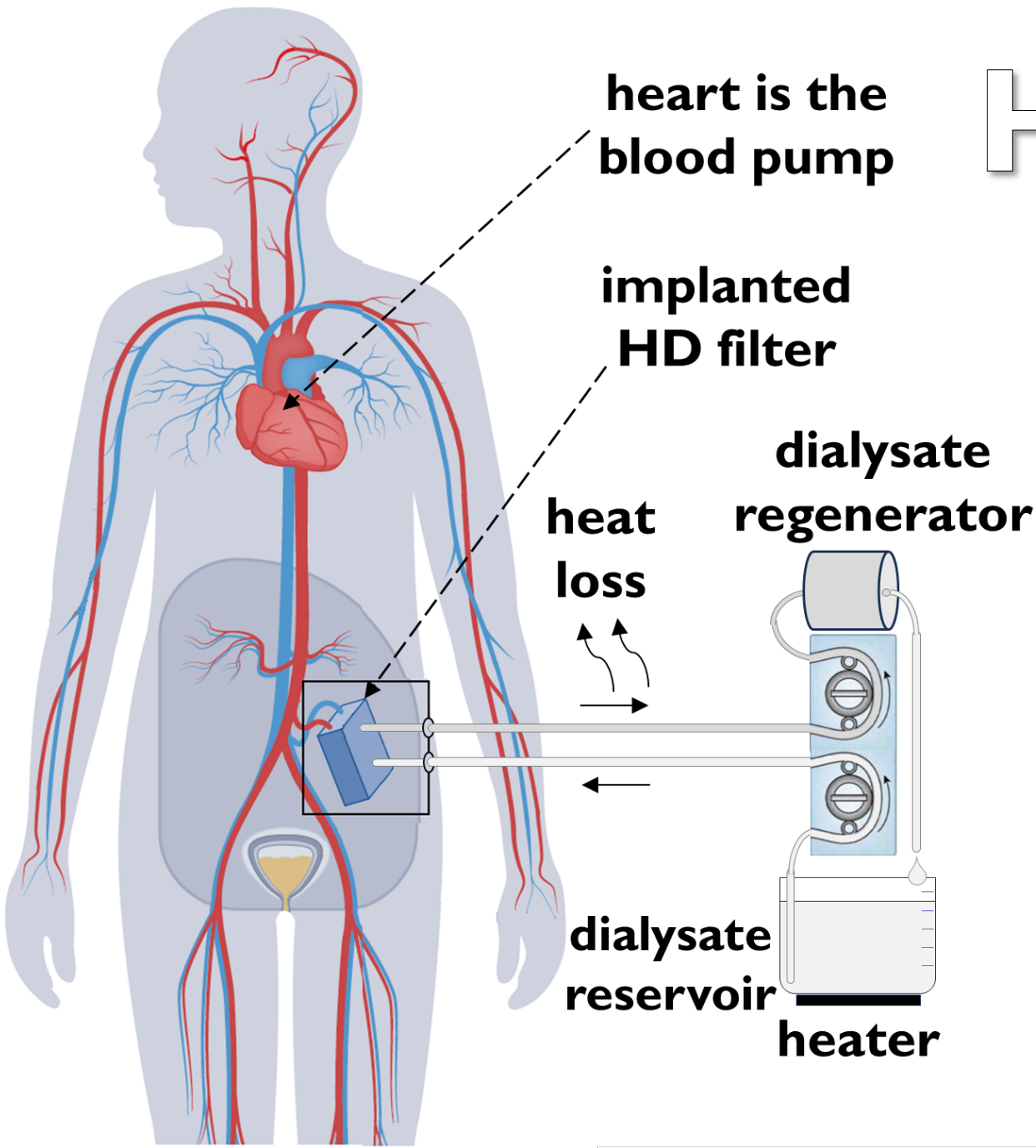


HD

Without Needles !!
Implanted Dialyzer

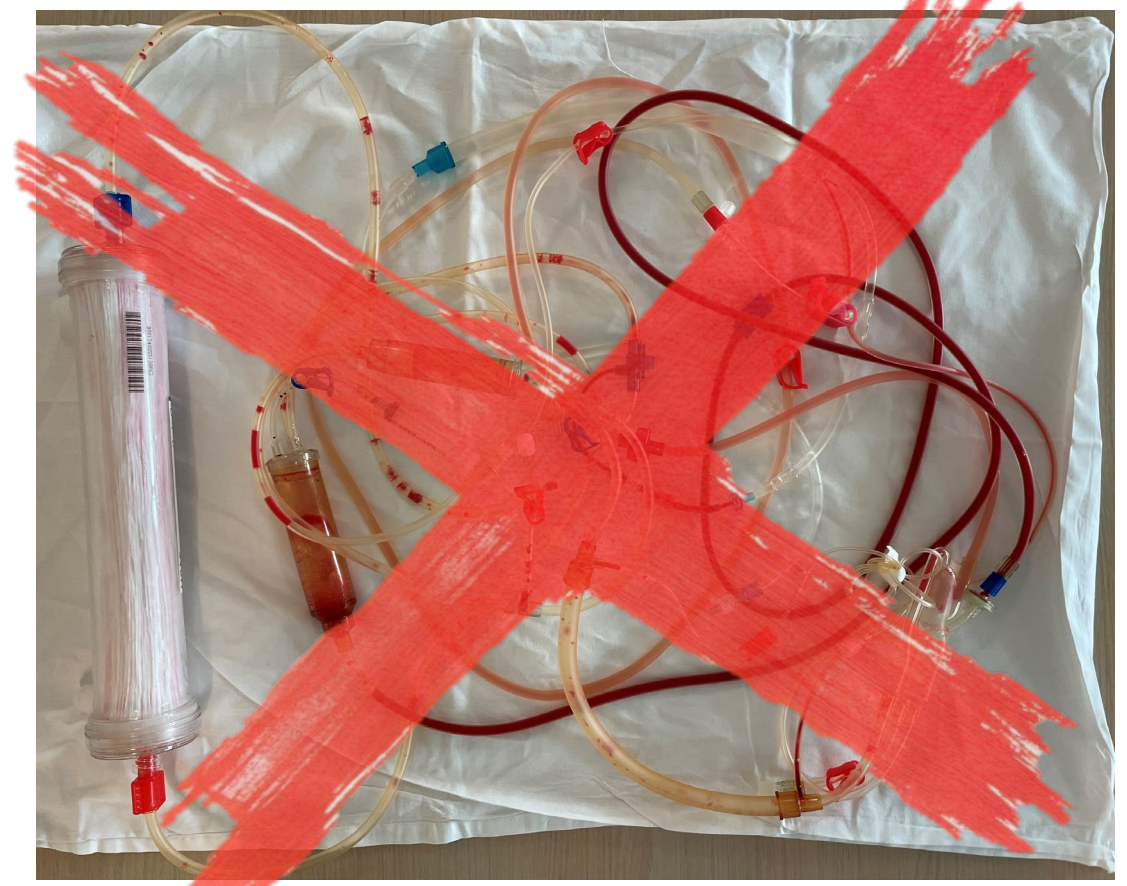


Only Dialysate Circuit is Extracorporeal ...

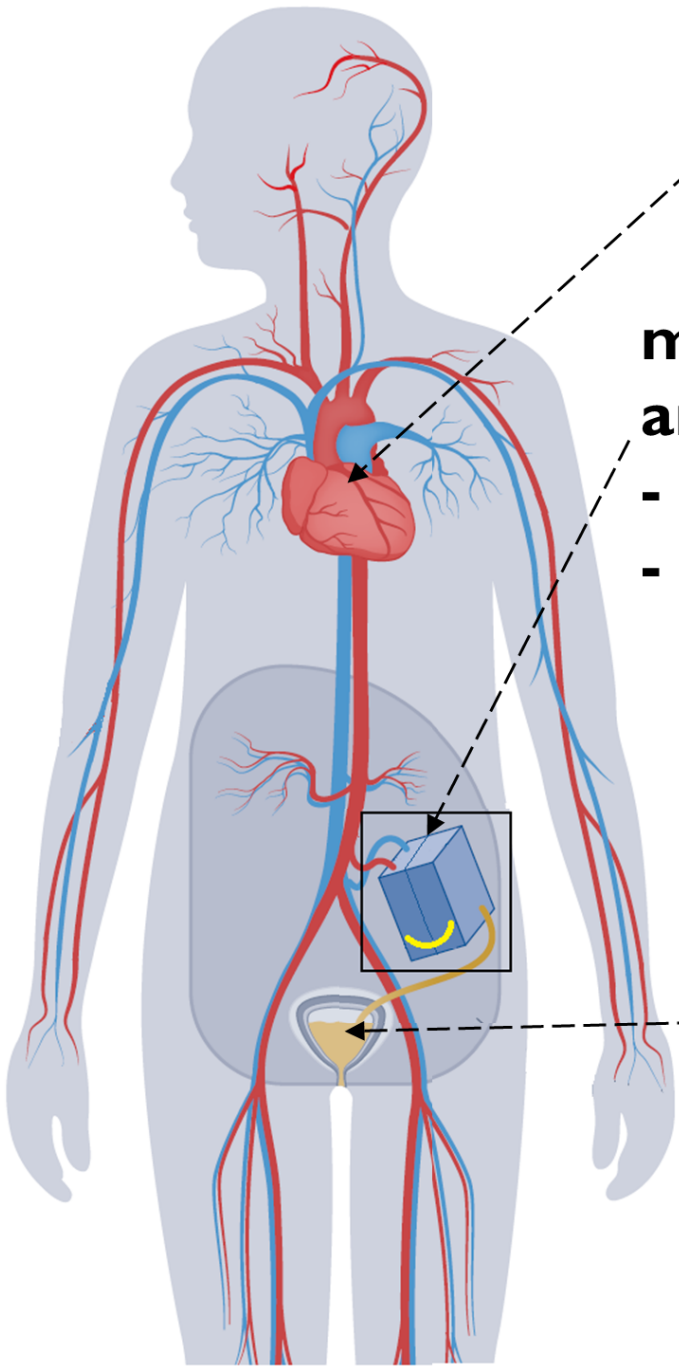


HD

Without Needles !!
 Implanted Dialyzer



Only Dialysate Circuit is Extracorporeal ...



**heart is the
blood pump**

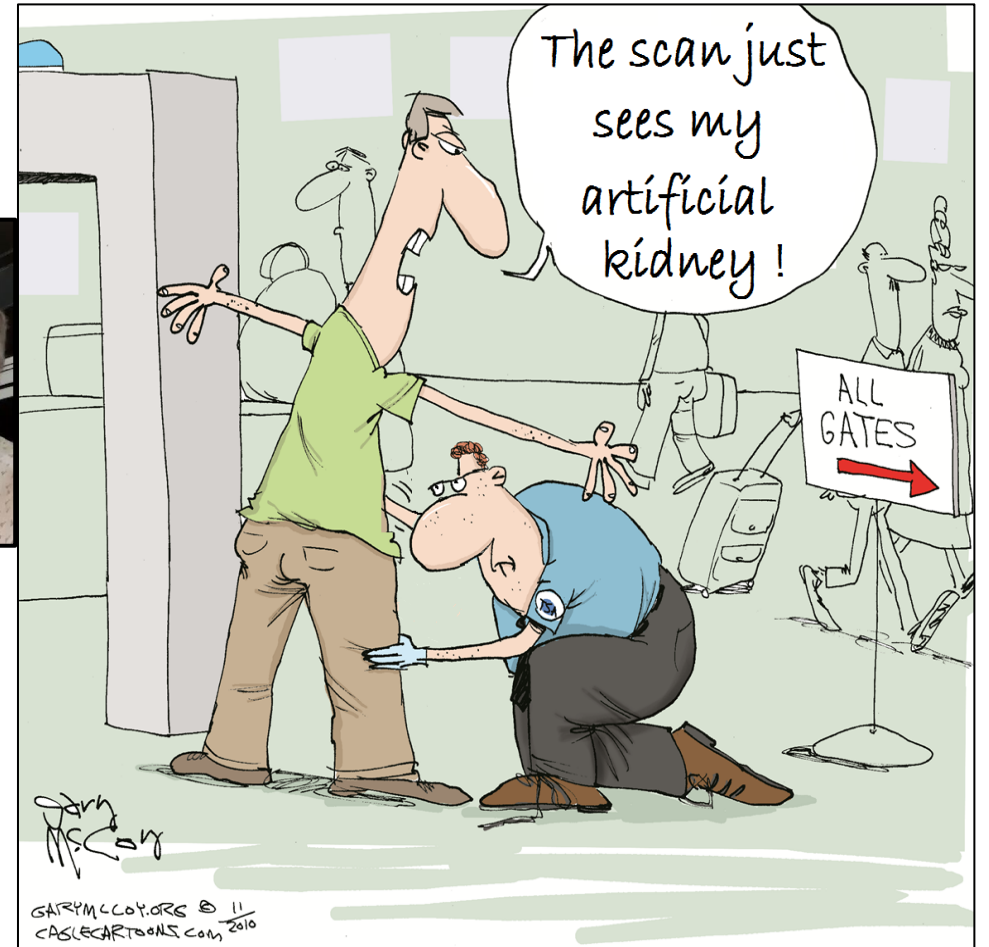
**modular implanted
artificial kidney:**

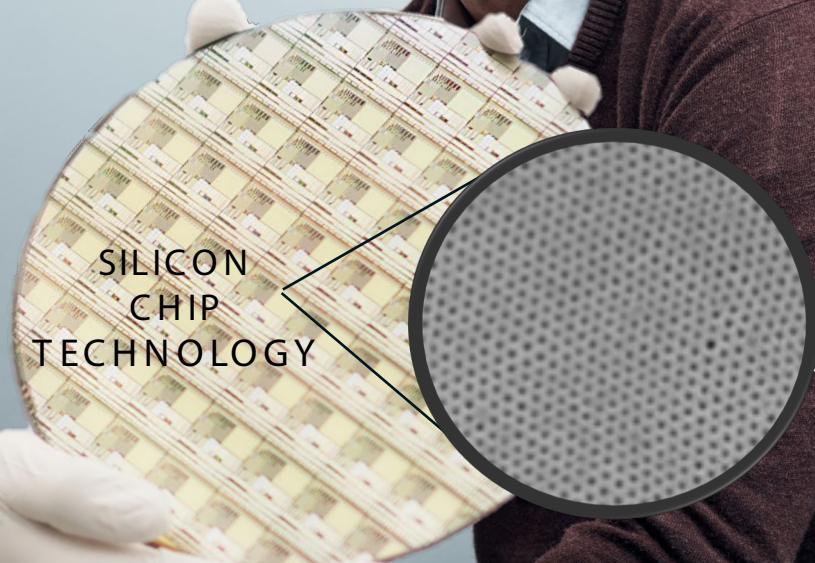
- dialysis filter
- bioreactor



**urine drains
into bladder**

24/7 (bio)artificial kidney





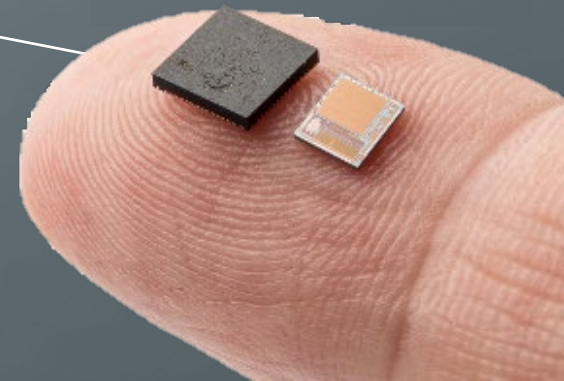
ULTRA-HIGH FLUX DIALYZER CHIP

BUILT-IN MONITORING



ARTIFICIAL KIDNEY

MINIATURIZED ELECTRONIC SYSTEMS-ON-CHIP

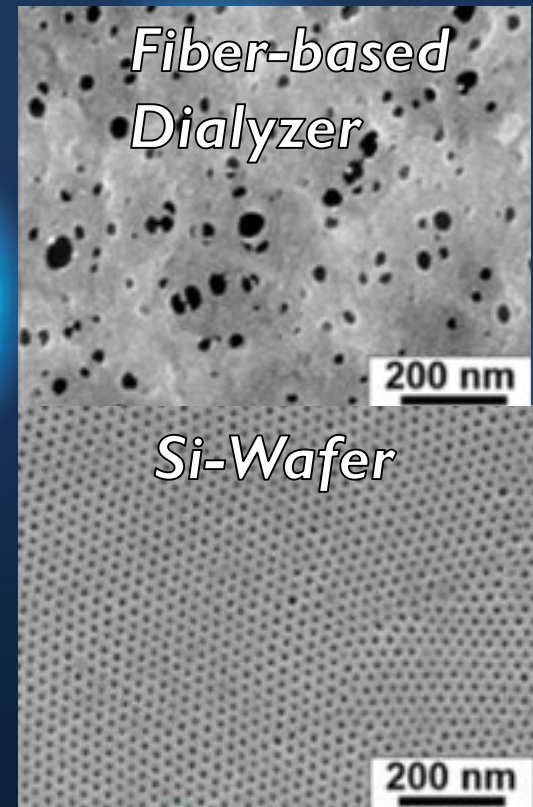
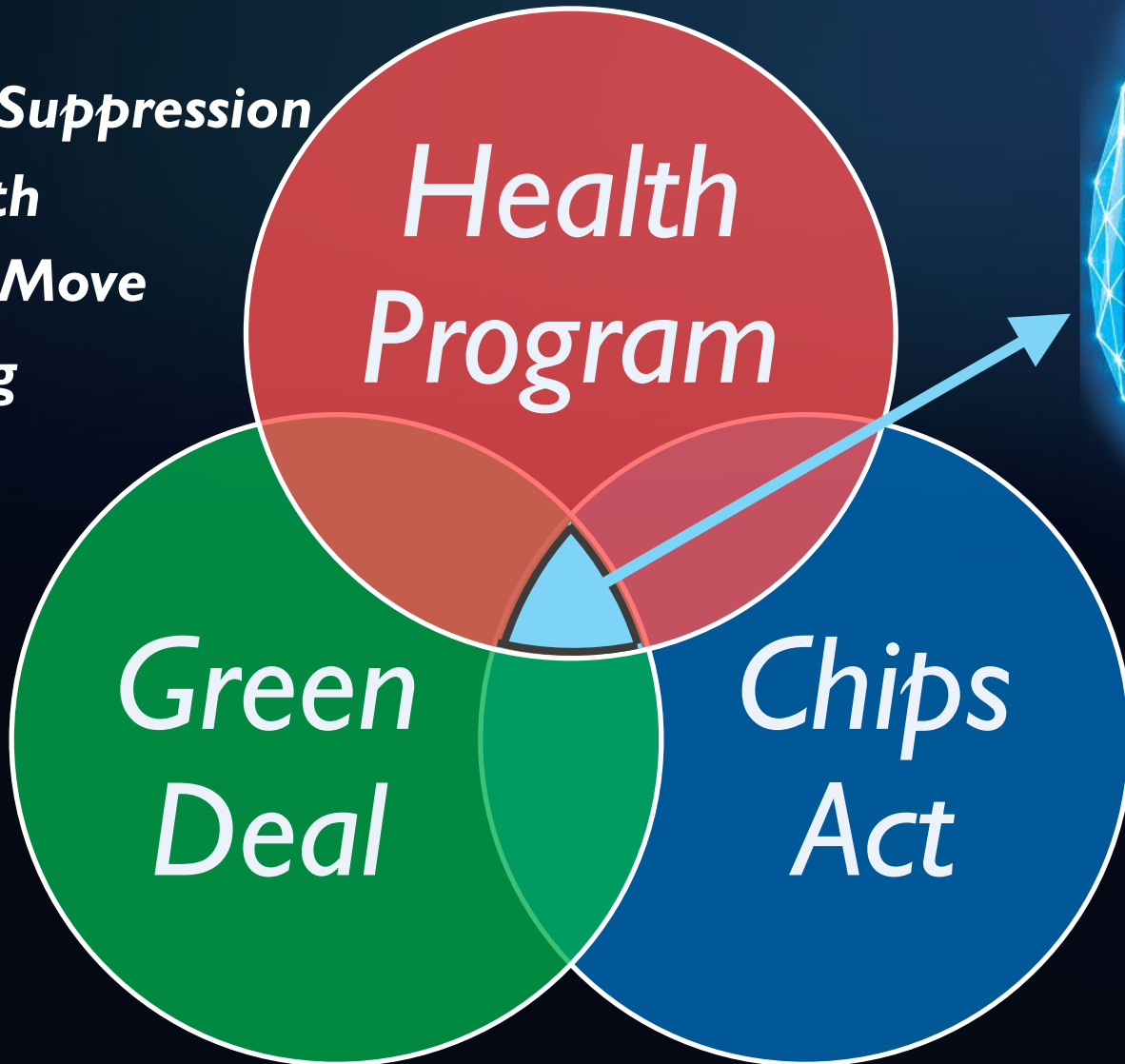


Financially supported by the Dutch Growth Fund and the HORIZON-EIC-2022 Pathfinder project 101099092



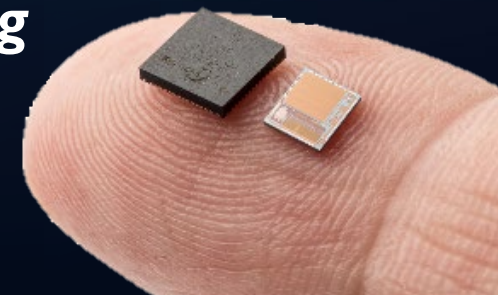
Ultra-miniaturization

No Immune Suppression
Better Health
Freedom to Move
No Needling



Saves Water,
Electricity
& Transport

Nanoporous Filters
Blood Compatible Coatings
Wireless Charging
& Telemonitoring
Sensors
Actuators
Control Unit



AJKD

AMERICAN JOURNAL OF KIDNEY DISEASES

COMING SOON

Perspective

AJKD

The Future of Technology-based Kidney Replacement Therapies: An Update on Portable, Wearable and Implantable Artificial Kidneys

Fokko Wieringa, Swathi Suran, Henning Søndergaard, Stephen Ash, Cian Cummins, Ashesh R. Chaudhury, Tugrul Irmak, Karin Gerritsen and Jeroen Vollenbroek



Fokko Wieringa

Assoc. Prof. Medical Technology

Technology Advisor NeoKidney

Advisory Board Member HDU

Member IEC/ISO & AAMI

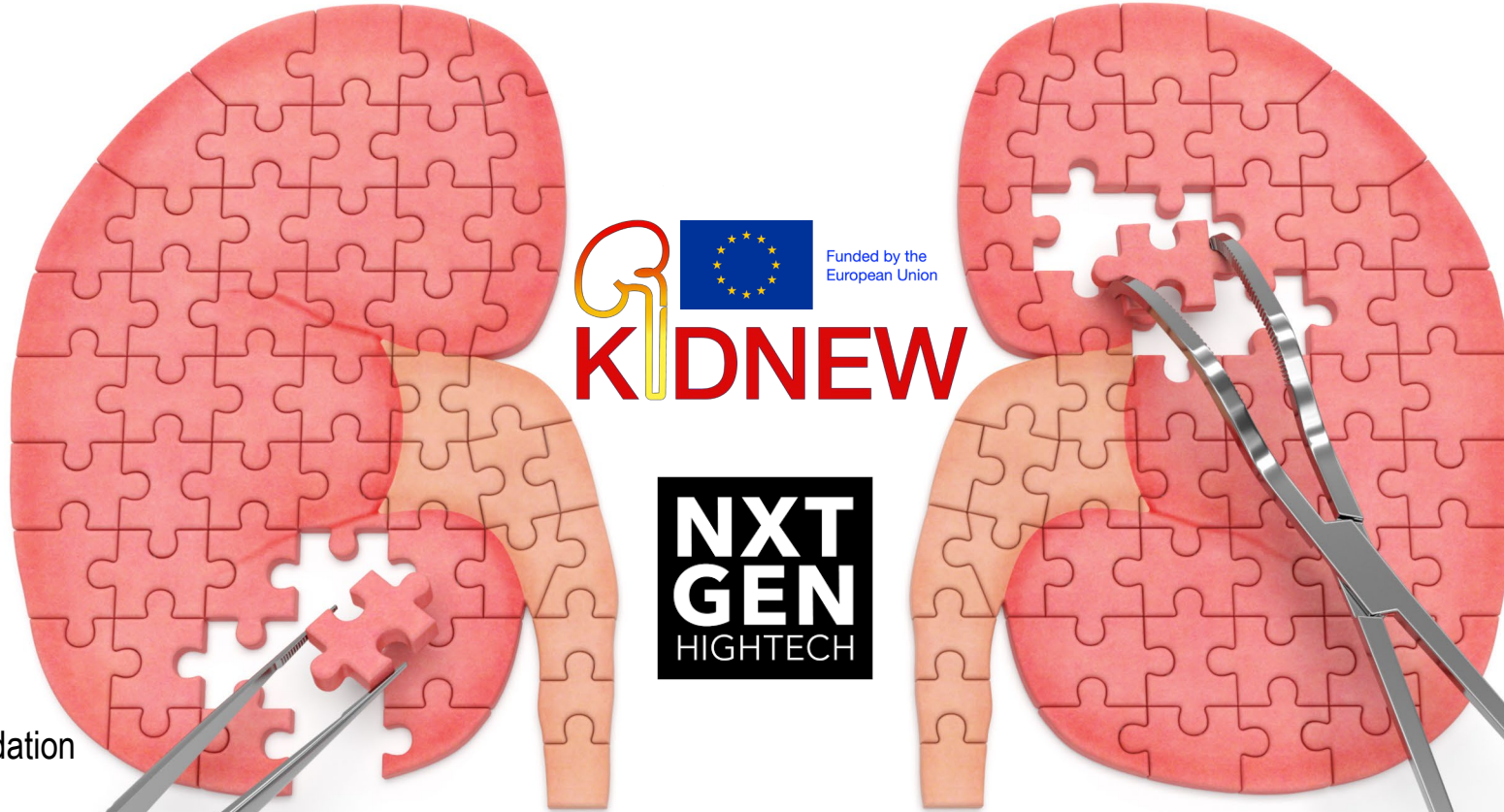
Chair EKHA WG 3

Member KHI

Board Member Willem Kolff Foundation

Fokko.Wieringa@imec.nl

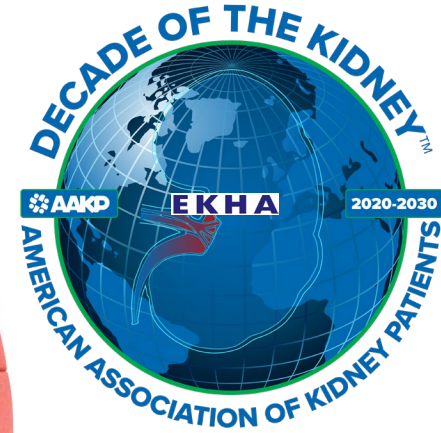
Phone: +31 6 22857326



Funded by the European Union



UMC Utrecht



WG3 "Breakthrough Innovation"



Pioneers Kolff & Van Noordwijk

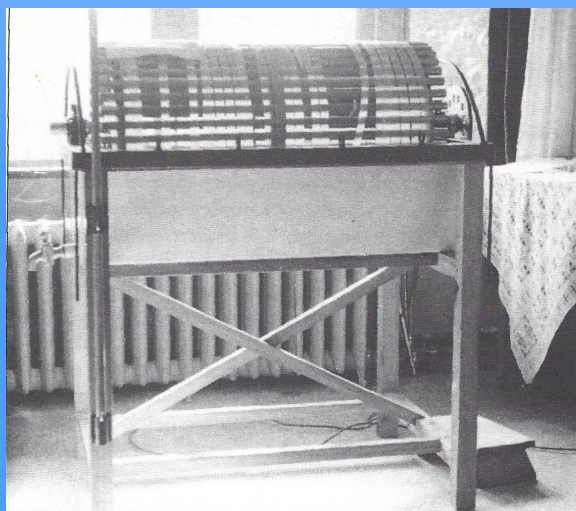
Symposium

Kampen, June 24th 2025

80 years Hemodialysis & 65 years A-V Shunt



Pioneers Scribner & Quinton

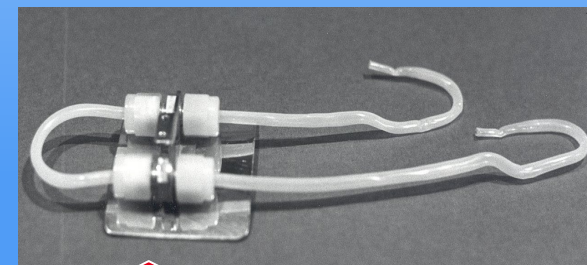


Willem Kolff Foundation



1945 Kampen, the Netherlands

1960 Seattle, USA



Pre-program of ESAO 2025

CLIMB AGAINST TIME

I need you: For a Future Free From Dialysis



Contact: Tugrul Irmak
E-mail: t.irmak@umcutrecht.nl



AKTUELLESTES WISSEN - KOMPAKT AN 2 TAGEN

- Kurz und praxisnah: Die wichtigsten Publikationen der letzten 12 Monate
- 3in1: Topics interdisziplinär diskutiert
- Cases²: Spannende Kasuistiken interaktiv präsentiert
- Digitale Zusatzinhalte: Seminarskripte und Charts
- Alle Vorträge als Video-on-Demand

WISSENSCHAFTLICHE LEITUNG



Prof. Dr. Mario Schiffer



Prof. Dr. Timm Westhoff

**Jetzt Ticket
buchen**



Ihr innovatives Update -

Von führenden Expert:innen präsentiert und diskutiert