

Summary of the 2020 IFAO-ASAIO Session on Implantable Artificial Kidney

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For the 2020 meeting of ASAIO (American Society for Artificial Internal Organs), the International Federation for Artificial Organs (IFAO) planned a special session on the implantable artificial kidney (IAK) and the Kidney Implant Developers Network Worldwide “KIDNEW.” This session was in response to a request from Murray Sheldon, MD, of the FDA, on behalf of the Kidney Health Initiative (KHI). KHI is a public-private partnership that has expanded to include over 100 companies and organizations representing patients, care partners, health care professionals, industry, and government. A major goal of KHI is to encourage innovation in the treatment of patients with end-stage renal disease, especially with radically new approaches that go far beyond the standard peritoneal or hemodialysis used widely today. A renal replacement therapy (RRT) Roadmap has been created by KHI to encourage innovative approaches to RRT to address patients’ needs.¹ Although this roadmap is “agnostic” to the final form of RRT, the goal of an IAK is one of the most attractive eventual therapies and a recurrent subject of presentations at ASAIO.

With the assistance of Dr Sheldon and Fokko Wieringa, PhD, a list was created of many of the laboratories around the world that have focused on projects related to or directly leading toward a workable IAK. Dr Ash sent out invitations, and from the response, an impressive program was created (Table 1).

Due to the COVID-19 epidemic, the in-person ASAIO meeting for 2020 was canceled. ASAIO abstract presentations were taped by the speakers, using PowerPoint slides with audio description. These presentations are now available with a modest registration fee, through the ASAIO.org website. The IFAO and the organizers of the IAK “KIDNEW” session, however, decided to hold a truly interactive session, with speakers presenting in real time and with live audio questions and additional audience feedback recorded in text *via* a chatbox. The IAK “KIDNEW” session was held on June 12, the same day that the in-person session had been scheduled. Technical hosting of the

session was kindly provided by IMEC, in Eindhoven, the Netherlands. Drs Sheldon and Wieringa were cochairs. Members of ASAIO, European Society for Artificial Organs (ESAIO), Japanese Society of Artificial Organs (JSAO), and KHI comprised the audience, as well as speakers and audience from a virtual European Renal Association-European Dialysis and Transplantation Association (ERA-EDTA) sister-session regarding advances in RRT, which was held 3 days earlier on June 9. Both sessions were advertised jointly throughout the organizational networks of ASAIO, ESAIO, JSAO, IFAO, KHI, ERA-EDTA, and European Kidney Health Alliance. The presented combined progress was truly remarkable and showed tremendous potential.

Dr Sheldon opened the session with a pledge to consider “coopetition” as an approach to speed-up the RRT innovation roadmap, which is also described in a recent article in *Artificial Organs*.² The speakers at the session presented impressive new technologies for solving the numerous challenges of making an IAK capable of providing long-term and effective removal of uremic toxins:

- Dr Shuvo Roy showed impressive results with hemofilters made from silicon wafers, successfully implanted in pigs with 90% patency up to 30 days, plus a working cell-based bioreactor, functioning 3 days in a pig without inducing an immune reaction!

Table 1. Program of the ASAIO-IFAO Session on IAK and “KIDNEW”

An International Roadmap for Innovative Renal Replacement Therapy, Murray Sheldon, FDA, United States
The Kidney Project, Shuvo Roy, UCSF, United States
Development of New Artificial Kidney Technology, Jamie Hestekin, US Kidney Research Corporation, UCLA and University of Arkansas, United States
Ambulatory Kidney to Improve Vitality (AKTIV), Buddy Ratner, Center for Dialysis Innovation, University of Washington, United States
The (Re)building a Kidney Consortium, Iain Drummond, Mount Desert Island Biological Lab, United States
Implantable Blood Purification Devices, Morteza Ahmadi, Qidni, Canada
Membranes for (Bio)Artificial Kidney Devices, Dimitrios Stamatialis, University of Twente, the Netherlands
Regenerative Medicine Crossing Borders, RegMed XB: The Kidney Moonshot, Marianne Verhaar, Utrecht University of Medical Center, the Netherlands
Update on NeoKidney Consortium & KIDNEW, Fokko Wieringa, IMEC, and Dutch Kidney Foundation
Experiences from Semiconductor Roadmapping and Getting Disruptive Medical Technology Running Patrick de Jager, ASML, the Netherlands
Wrap-up Discussion and Action Points, led by Steve Ash, Fokko Wieringa, and Murray Sheldon

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ASAIO, American Society for Artificial Internal Organs; IAK, implantable artificial kidney; IFAO, International Federation for Artificial Organs; KIDNEW, Kidney Implant Developers Network Worldwide.

- Dr Jamie Hestekin showed a modular WAK design (to be miniaturized to IAK) using electrically steerable selective removal of Na⁺, Mg²⁺, K⁺, or Ca²⁺ ions by electrodeionization, as well as selective removal of glucose by nanofiltration, and selective water transport by reverse osmosis.
- Dr Buddy Ratner amazed with selective photocatalytic oxidation of urea using TiO₂ nanowires and STAR-polymer material that produces no foreign body reaction and is fully symbiotic with human tissue, which enables vascular grafts with unprecedented low infection rates.
- Dr Iain Drummond updated upon impressive progress made by the (Re)building a kidney consortium on cell lines, organoids, three-dimensional-printing of nephron structures, and a great data hub while calling his role in the consortium as “the plumber” that connects all components.
- Dr Morteza Ahmadi updated on the Qidni device tested in a pig, which utilizes ultrathin nanoporous silicon membranes and a connection to the bladder.
- Dr Dimitrios Stamiatis presented mixed matrix membranes for enhanced removal of protein-bound toxins, as well as selective sorbents for urea and a hollow fiber membrane with living cells embedded.
- Dr Marianne Verhaar gave an overview of the 250 million Euro Dutch/Belgian research consortium RegMedXB, which works on regenerating tissue with intelligent, life-like materials, like supramolecular materials that offer tunable properties and provide very promising results. RegMedXB also has interesting computational models.
- Dr Fokko Wieringa provided an overview of the NeoKidney initiative from the Dutch Kidney Foundation (that also supports RegMedXB), the first step on their roadmap is now nearing completion with the launch of NextKidney, but an IAK is the ultimate long-term goal.
- Dr Patrick De Jager showed us all the great progress made possible by numerous scientists and businesses in “co-opetition” bound by an overall roadmap for progress, as for decades has been successful practice within the

semiconductor industry, using Moore’s law. He also provided a real-world MedTech example of how he applied these roadmapping processes, resulting in significant investment from a Belgium company to develop and realize production of isotopes for nuclear medicine *without* a nuclear reactor.

The concluding discussion was characterized by a highly cooperative atmosphere. Offers were made to share cell-lines, for follow-up discussions on technical cooperation. The Dutch group in Utrecht needed a “plumber” to connect their cells, and was immediately offered help from the United States and Daniel Gosset from NIH-NIDDK offered to provide an overview of calls for renal innovation, which he promptly did. The list of NIDDK-sponsored programs to improve kidney failure therapy is available at <https://asaio.org/multimedia/files/virtual/Proposals.pdf>.

The entire session, including presentations, audience questions, and speaker responses, was videotaped. The lively two-hour session is available through a link at the ASAIO.org website or directly at https://www.youtube.com/watch?v=Rx5LOWv_qkw&feature=youtu.be. We encourage you to watch the video. All speakers at this IAK “KIDNEW” session have been invited for an update-session during the 2021 ASAIO meeting in Washington, DC. It will be fascinating to see how much progress has been made by these very special and dedicated researchers.

The ERA-EDTA sister-event can also be viewed, *via* <https://nierstichting.nl/professionals/webinar/>.

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